

*A Semimonthly Technical Newspaper*

# **Metallurgical & Chemical Engineering**

New York, January 15, 1918

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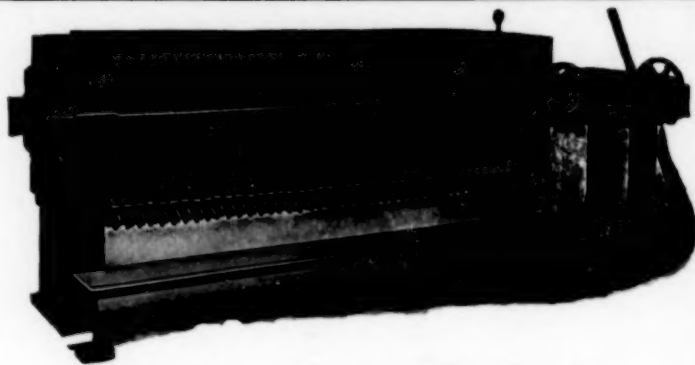
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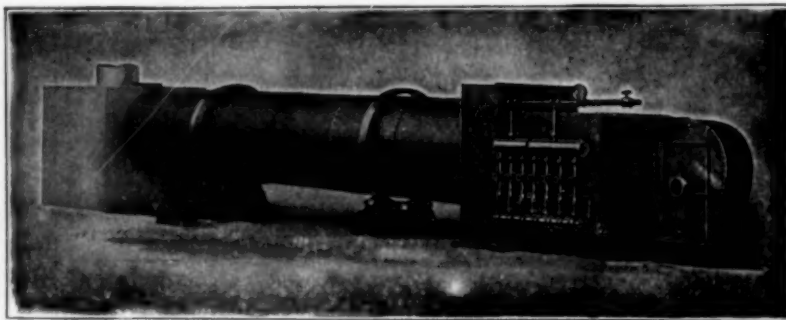
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# Metallurgical and Chemical Engineering

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## Outlook for Water-Power Legislation

IN his message to the Congress last December the President said:

"It is imperatively necessary that the consideration of the full use of the water power of the country \* \* \* should be immediately resumed and affirmatively dealt with at the earliest possible moment. The pressing need of such legislation is daily becoming more obvious."

By emphasizing the "full use of the water power of the country" and the "pressing need" which is "daily becoming more obvious," the President shows his appreciation of the fair demands of all sections of the country and condemns the delay in legislation which has brought us to a state of pressing need for power. The government, being temporarily in the business of waging war, is suddenly brought to a realization of a condition which industry and private business have long since recognized.

Aside from Niagara and other projects that might be developed on boundary streams, which must be dealt with by international treaty, there are internal sources of water power subject only to our own legislation. These are upon navigable streams, public lands and national forest reserves. By our system of national organization the control of these three sources is vested in three separate departments of the government, viz., War, Interior and Agriculture respectively. This in itself is a complication that has proved a formidable barrier to progress in federal legislation, for hitherto it has seemed necessary to initiate special bills for each department in both houses of Congress.

It may be considered a stroke of policy, therefore, on the part of the Administration to attempt to surmount past obstacles by introducing in the House a new bill which has been drafted under the direction of the Secretaries of War, Interior and Agriculture covering all internal water power development, and which they consider most "likely to secure extensive development of this resource." A digest of this new measure is given on another page in this issue. The bill embodies the fundamental features of several bills previously introduced in Congress, and aims to avoid their defects. In this it is largely successful, although a few moot points will have to be settled before the bill is passed if it is to be productive of actual development.

The term "actual cost" is used without definition in that section of the bill which provides for the taking over by the government of any project at the expiration of the term of license. Unless this term is clearly and satisfactorily defined, it would be fruitful of controversy in the transfer of any project from the licensee to the government. Indeed, failure to define the term would defeat the purpose of the bill, for prospective licensees would not be inclined to invest in a project the



value of which is to be determined only by future agreement between the Federal Power Commission and the licensee, or by proceedings in equity in a federal district court. Other provisions of the bill which probably will be modified relate to the issuance of new licenses at the end of a fifty-year period, and to the possible confusion in federal and state regulation of the licensee's securities, rates and service. It is practically assured that the bill will pass the House almost without debate. At this writing no such certainty exists with respect to the Senate, but it is more than likely that that body will fall in with the Administration's plan.

It will be a matter for congratulation if Congress shall act intelligently and quickly in this matter. Surely that body of men must have shared with the rest of us the feeling of impotence in our recent coal shortage and transportation difficulty, most of which would not have existed if we had long since developed our water powers. No more striking example should be needed of the folly of using coal so extensively for lighting, transportation and power—exhausting a resource which can serve us but once and neglecting another that is inexhaustible. Our lack of extensive hydro-electric development has made necessary the employment of much labor and rolling stock in the mining and transportation of coal. Most of this labor could have been released for productive work in other industries, and the rolling stock would have been available for transporting food, munitions and supplies, if we had been foresighted enough to develop a resource just at hand. We should have been in worse straits but for the projects already developed in the West which are supplying railroads, mines and cities with power. Dozens of undeveloped sources of water power still remain in the West and in other parts of the country, placing on us the duty of exerting every legitimate effort to see that Congress does not fail the nation at this critical time.

### Analyzing for Traces

IT is doubtless a truism to remark that when a scientist digs deeper into the unknown, he little knows the infinite possibilities of the knowledge he uncovers. By that same token, works' chemists and metallurgists will cordially welcome the acquaintance of a new branch of so-called "pure science," namely, "the spectroscopy of the ultra-violet." In this wise:

Many modern chemical and metallurgical products are pure—containing smaller impurities than the familiar "chemically pure" reagents—and are shipped as such in enormous quantities. The final processes in the refining of such materials demand intermediates, solutions, or melts of extraordinary purity, and of course the chemical control requires most precise analysis for minute traces of foreign bodies.

In the remelting of copper wire and scrap, the bath must be worked until the lead, introduced by pieces of lead-covered cable, is below a certain small fraction, depending upon the ultimate use of the copper. Or, take as another instance, the zinc sulphate solution from which electrolytic zinc is precipitated. This solution must be free of cadmium, iron and copper (among other elements), not nearly free, but really free. Since it takes an expert analyst about three days to make a cadmium determination, in the meantime the electrolyte has been electrolyzed! Not only

this, but few chemists who are skillful enough or reagents which are pure enough to analyze for traces are available in war times.

Messrs. Hill and Luckey presented a paper before the last American Electrochemical Society meeting (METALLURGICAL AND CHEMICAL ENGINEERING, Dec. 1, 1917, page 659) showing how a spectrograph can be used for quick determinations of traces of lead in a copper bath, which analysis is necessary in the first instance cited above. The spectrum has also been adapted for the determination of coloring matter in wines, the detection of blighted wheat flour, nitrates in water, phosphorus in suspected poisoning, and in the analysis of sugar and essential oils.

These instances are only an indication of the future usefulness of the method. While qualitative spectrum analysis is familiar to elementary students, quantitative spectrum analysis is a comparative stranger to experts, and seems to be confined to the determination of very small amounts of material—less than ten parts per million. That is exactly what is required in many metallurgical and chemical processes, and further intensive research along this line will undoubtedly prove to be very stimulating and highly productive of badly needed "short cuts."

### The Present and Future of Potash

A TRITE expression that has gained currency in recent months informs us that any one of a dozen or so commodities "will win the war." The range is wide—from sugar to coal, wool to sulphuric acid. The expression has lost much of its earlier force, and the idea which it conveys has become as preposterous as the thought that the war can be won by the simple expedient of "doing our bit." Both expressions should be dropped from our war vocabulary, because the facts are that no single commodity will win the war, and we are only deceiving ourselves if we think that "our bit," or anything short of our all, will be sufficient.

All this is parenthetical to a brief consideration of potash as a war mineral, which, if it will not "win the war," is nevertheless of vast economic importance. Practically all the potash used in this country has normally come from Germany. The elimination of that supply threw us upon our own resources to meet pressing needs. Accordingly we took stock of the possibilities, and produced potash from natural brines, alunite and silicate rocks, cement-kiln and blast-furnace dust, kelp, wood ashes, beet and cane molasses, and distillery waste. In other words, we have made every possible source yield some potash, although much of the present industry is on strictly a war basis, and probably cannot continue in normal times.

Natural brines have been the most productive of all domestic sources. Alkali lakes in western Nebraska have been made to support a large industry, recently described in this journal. This development may not be able to survive a return to normal conditions, although the prospects will be better if methods of operation are improved. Searles Lake, in California, on the other hand, bids fair to be a real factor in supplying a large part of our needs. But whatever the future of potash from brines, it is certain that these lakes afforded the most readily available supply in our emergency.

The extraction of potash from silicate rock has been



an attractive proposition on account of the abundance of the material. Potash forms nearly 3 per cent of the earth's crust, and there are several silicate rocks containing the compound to the extent of 10 to 15 per cent. But if the material is abundant it is also chemically combined in such form as to be difficult of extraction, so that actual production from this source has lagged; this, too, in spite of a vast amount of research and experimentation, as indicated in the bibliography we are now publishing. So abundant and widely distributed a resource, however, is not likely to remain unutilized, and it seems reasonable to contemplate the possibility of supplying therefrom a large part of the world's demand for potash. With this in prospect, the reader will find some impressive figures in the interesting article in this issue contributed by Mr. Washington, who tells the potash story of Italian volcanoes.

Recovery of potash from kelp, a seaweed of common growth along our Southern Pacific coast, is likewise a most interesting problem. In the past few years we have developed an industry in California in which the investment aggregates between three and four million dollars. This is a large investment in a business which, frankly, will not be profitable after the war if German potash is again imported at pre-war prices. If the war continues long enough, the cost of plants can be amortized and the business abandoned when competition again exists. But this is not a pleasant prospect; we would far rather see the industry firmly established on a sound technical basis and able to hold its own. One difficulty at present is that none of the operators is willing to conduct any research. They feel that it is their business to make potash while they can, at present prices, because they know the precarious nature of their industry. This is all right for the present, but not satisfactory for the future. Hence the greatest importance attaches to the government experimental kelp farm on the California coast, where the problems are being attacked in a scientific manner by the Department of Agriculture with an eye to the future stability of the industry. The chief problems are those of drying and distillation, coupled with recovery of all possible by-products from the latter process, such as tar, ammonia and combustible gases. The object of the farm and plant is to determine whether potash can be produced from kelp at a profit or loss. The results will give a fairly definite answer to the question of the importance of kelp as a source of potash after the war.

### Restricted Steel Output

IT makes a poor showing indeed that the steel ingot production of the United States in 1917 was only about 42,000,000 tons, as just estimated by the American Iron and Steel Institute, against 41,400,000 tons produced in 1916, for there was new open-hearth steel-making capacity completed in 1916 to the extent of fully 4,000,000 tons, and a like amount of new capacity was added in 1917. As new construction began, and in only a very humble way, in June, 1915, the 1916 new capacity must have come in chiefly toward the latter part of the year, while the new construction in 1917 cannot have fallen preponderatingly toward the close of the year. Hence, with full operation of existing capacity throughout both years, the increase from one calendar year to the next should have been in excess of 4,000,000 tons, instead of only 800,000 tons.

The restriction in steel ingot output in 1917 was due chiefly to a shortage of pig iron. Whether under the most favorable operating conditions at the blast furnaces they could have produced enough pig iron to supply all the steel-making capacity is a question. What is well known is that the blast furnaces did not operate at capacity in 1917. Pig-iron production was about 800,000 tons less than in 1916, whereas there was much more capacity. From May 13, 1916, to the end of the year four new blast furnaces were blown in, and in 1917 there were 14 new blast furnaces completed, largely about the middle of the year, the 18 stacks being fully equal to a production of 2,000,000 tons of pig iron a year.

While it may be true that if the chief bar to full production of pig iron in 1917 had not existed various other minor influences might have been felt, the outstanding fact is that pig-iron production in 1917 was held at the low level shown because not enough coke was moved from the Connellsville coke region to the blast furnaces depending on the region. There was a decrease in that movement, from 1916 to 1917, of nearly 4,000,000 tons. As to the cause, there was much "passing the buck" during the year, chiefly between the operators and the railroads. The operators claimed car supplies were insufficient, the railroads rejoining that when more cars were furnished they were not loaded, whereupon the coke operators came back and asserted that in periods of enforced idleness their labor drifted away. Toward the close of the year they claimed they had much more labor than formerly, but car supplies were still poorer. Obviously a condition existed which required team work, and the United States Government has become the "big boss." At the end of the old year it took over the operation of the railroads and on Jan. 3 Warren S. Blauvelt, national coke administrator, addressed the coke operators of the Connellsville region at Uniontown, assuring them that full transportation facilities would be provided and insisting that there must be full production of coke or something would be done by Washington.

What is particularly distressing in the situation is that the deficit in coke supply, particularly as regards the conditions of the past few months, is less than the amount by which Connellsville coke shipments have decreased. If the region were shipping as much coke as in 1916 there would be a surplus of coke. The completion of by-product ovens has been such as to take care of the increase in blast furnace capacity.

It is to be hoped that relief as to supplies of Connellsville coke will be afforded very shortly. In another direction a measure of relief of no small consequence will be provided, as the by-product plant of 640 ovens at Clairton is nearing completion and may make its first coke by April 1, with full production of the 640 retorts not long afterward. Their expected output is 2,740,000 tons of coke a year, on the conservative estimate of a 67 per cent yield, with nearly 7000 cu. ft. of gas per ton of coke made, the gas in turn doing its bit to relieve the fuel situation, for all the coal consumed at the Clairton plant will be brought by water. As the coke will be distributed to the various blast furnaces by the Carnegie Steel Company's own interplant road the entire operation will be independent of the railroads.

## Readers' Views and Comments

### Mill Pumping Systems: Frenier Pump Capacities

To the Editor of Metallurgical & Chemical Engineering

SIR:—I regret that, through an error in typing, the Frenier pump capacities appearing in your Dec. 1 issue were underestimated by the omission of the final "0" in each case. The table should have read:

Size, Inches	SPECIFIC GRAVITY OF FLUID					
	1,000	1,100	1,200	1,300	1,400	1,500
	Tons per 24 Hours					
44 by 6						
48 by 6						
54 by 6	450	400	540	580	630	670
44 by 8						
48 by 8	540	590	660	700	760	810
54 by 8						
44 by 10						
48 by 10	630	600	760	820	880	940
54 by 10						

These capacities are based on moderate lifts, precise adjustment and maintenance of level of liquid in the box, and free discharge. If any one of these conditions is impracticable the figures should be reduced accordingly.

A. W. ALLEN.

Denver, Colo.

### Conversion Table: Pounds to Grams

To the Editor of Metallurgical & Chemical Engineering

SIR:—The accompanying table will serve as a convenient means of rapidly converting pounds avoirdupois into grams. The facility with which this operation may be performed will be quite apparent, but the following description will not be out of place:

In Table I, pounds avoirdupois (1 to 9) are indicated by figures in left-hand column. The metric units are indicated by headings along the upper border. One pound (avoirdupois) equals 453.5924 grams, or 453.59 decagrams, or 453592.4277 milligrams.

TABLE I

POUNDS	GRAMS									
	KILO-GRAMS	HECTO-GRAMS	DECA-GRAMS	GRAMS	DECI-GRAMS	CENTI-GRAMS	MILLI-GRAMS			
1	0	0	4	3	5	9	2	4	2	7
2	0	0	9	0	7	1	8	4	5	4
3	0	1	3	0	0	7	7	7	3	1
4	0	1	8	1	4	3	6	9	7	1
5	0	2	2	6	7	9	6	2	1	3
6	0	2	7	2	1	5	5	4	3	6
7	0	3	1	7	5	1	4	0	9	3
8	0	3	6	2	8	7	3	9	4	2
9	0	4	0	8	2	3	3	1	5	4
POUNDS	TEN-THOUSANDTHS	THOUSANDTHS	HUNDREDTHS	TENTHS	UNITS	TENS	HUNDREDS	THOUSANDS	TEN-THOUSANDS	HUNDRED-THOUSANDS
1	0	0	4	3	5	9	2	4	2	7
2	0	0	9	0	7	1	8	4	5	4
3	0	1	3	0	0	7	7	7	3	1
4	0	1	8	1	4	3	6	9	7	1
5	0	2	2	6	7	9	6	2	1	3
6	0	2	7	2	1	5	5	4	3	6
7	0	3	1	7	5	1	4	0	9	3
8	0	3	6	2	8	7	3	9	4	2
9	0	4	0	8	2	3	3	1	5	4

TABLE II—VALUE OF DECIMAL PARTS OF A POUND IN GRAMS

Oz.	Parts	Value	Oz.	Parts	Value	Oz.	Parts	Value
	.01	4.535 924		.35	158.787 350	11		311.844 794
	.02	9.071 849		.36	163.293 274		.60	312.978 775
	.03	13.607 773		.37	167.829 198		.7	317.514 699
	.04	18.143 697	6		170.097 160		.71	322.050 624
	.05	22.679 621		.38	172.365 123		.72	326.586 548
	.06	27.215 546		.39	176.901 047		.73	331.122 472
1	.0625	28.349 627		.4	181.436 971		.74	335.658 396
	.07	31.751 470		.41	185.972 895	12		340.194 321
	.08	36.287 394		.42	190.508 820		.76	344.730 245
	.09	40.823 318	7		198.446 687		.77	349.266 169
	.1	45.359 243		.43	195.044 744		.78	353.802 094
	.11	49.895 167		.44	199.580 668		.79	358.338 018
	.12	54.431 091		.45	204.116 592		.8	362.873 942
2	.125	56.699 653		.46	208.652 517		.81	367.409 866
	.13	58.967 016		.47	213.188 441	13		368.543 847
	.14	63.502 940		.48	217.724 365		.82	371.945 791
	.15	68.038 864		.49	222.260 290		.83	376.481 715
	.16	72.574 788	8		226.796 214		.84	381.017 639
	.17	77.110 713		.51	231.332 138		.85	385.553 564
	.18	81.646 637		.52	235.868 062		.86	390.089 488
3	.1875	85.048 580		.53	240.403 987	14		396.803 374
	.19	86.182 561		.54	244.939 911		.87	394.625 412
	.2	90.718 486		.55	249.475 835		.88	399.161 336
	.21	95.254 410		.56	254.011 760		.89	403.697 261
	.22	99.790 334	9		255.145 741		.9	408.233 185
	.23	104.326 258		.57	258.547 684		.91	412.769 109
	.24	108.862 183		.58	263.083 608		.92	417.305 033
4	.25	113.398 107		.59	267.619 532		.93	421.840 958
	.26	117.934 031		.6	272.155 457	15		425.242 901
	.27	122.469 955		.61	276.691 381		.94	426.376 882
	.28	127.005 880		.62	281.227 305		.95	430.912 806
	.29	131.541 804	10		283.495 267		.96	435.448 731
	.3	136.077 728		.63	285.763 229		.97	439.984 655
	.31	140.613 653		.64	290.299 154		.98	444.520 579
	.32	141.747 634		.65	294.835 078		.99	449.056 503
5	.32	145.149 570		.66	299.371 002	16		453.592 428
	.33	149.685 501		.67	303.906 927			
	.34	154.221 425		.68	308.442 851			

Along the lower border are indicated the numerical denominations, located in a manner that permits them to be used as multipliers or divisors for the pound unit values.

As an example, it is desired to know the value of 5.5 pounds in grams.

From the value opposite the index figure 5 read 2267.9621385, and then it is quite obvious that .5 would be one-tenth of the above amount, or

$$5 \text{ lb.} = 2267.9621385 \text{ g.}$$

$$.5 \text{ lb.} = 226.79621385 \text{ g.}$$

$$5.5 \text{ lb.} = 2494.75835235 \text{ g.}$$

Table II will serve the purpose of representing the value of decimal parts of a pound avoirdupois, varying by one-hundredths.

The value of 5.5 pounds in grams may be read direct from the table by shifting the decimals in the value opposite .55 pounds.

It will also be noted that the exact decimals representing the ounces in a pound are shown in the column of figures headed "Oz."

DWIGHT GERBER.

Pittsburgh Terminal Railroad & Coal Co.,  
Pittsburgh, Pa.



## Determination of Phosphorus in High-Speed Steels

To the Editor of Metallurgical & Chemical Engineering

SIR:—The writer has the issues of METALLURGICAL & CHEMICAL ENGINEERING for Feb. 1, Dec. 1 and Dec. 15, 1917, before him, open respectively to the contribution of Mr. E. C. Kraus concerning determination of phosphorus in high-speed steels, the writer's comments thereon, and Mr. Kraus' reply to the writer.

From Mr. Kraus' own statement the vital points in his contribution are two in number. First, the elimination of tungsten without evaporation and subsequent "baking," and second, the elimination of interference of vanadium in the precipitation of phosphorus by reduction with sulphurous acid.

Regarding these two significant points of his contribution, it is common knowledge that  $WO_3$  does not require "baking" to render it insoluble in an aqua regia solution, and that "baking" is resorted to only when silicon is to be determined, as well as tungsten and phosphorus, from the same sample-weight. Obviously, then, the only point for which credit could be claimed was the elimination of the interference of vanadium.

The contention of the writer in his comment appearing in the Dec. 1 issue of METALLURGICAL & CHEMICAL ENGINEERING was that credit for this time-saving procedure should go to two Bureau of Standards chemists. In looking over his files to ascertain the names of these chemists, the writer finds that he was in error when he stated that the article concerning investigations in the precipitation of phosphorus in the presence of vanadium appeared in METALLURGICAL & CHEMICAL ENGINEERING in 1913. The publication to which the writer had reference was *Technological Paper No. 24* of the Bureau of Standards, written by J. R. Cain and F. H. Tucker, published May 17, 1913. The use of sulphurous acid in eliminating interference of vanadium in this determination is also incorporated in Standard Methods of Analysis as given in A. S. T. M. Year-book for 1915. Both of these publications antedate considerably Mr. Kraus' communication. The writer merely worked out the application of the procedure, as outlined by J. R. Cain and F. H. Tucker, to the method then in use, involving the separation of tungsten as a necessary preliminary to the determination of phosphorus.

Plattsburg, N. Y.

W. T. SHEFFIELD.

\* \* \*

To the Editor of Metallurgical & Chemical Engineering

SIR:—As I am somewhat interested in the recent discussion regarding the determination of phosphorus in high-speed steel, by W. T. Sheffield and E. C. Kraus, I wish to corroborate Mr. Sheffield's statement that his method was worked out in this laboratory during the fall of 1913.

While talking with Mr. Kraus last summer concerning his method I do not remember having made reference to a similar method of previous origin—a fact which I unintentionally omitted. However, we had been using Mr. Sheffield's method in this laboratory for some time before the article by Mr. Kraus was published. The sole purpose of this letter is to corroborate Mr. Sheffield's dates.

O. L. VAN VALKENBURGH.

Crucible Steel Company of America,  
Sanderson Bros. Works,  
Syracuse, N. Y.

The pertinent facts being established, the discussion is closed.

—EDITOR.

## Power from Coal

To the Editor of Metallurgical & Chemical Engineering

SIR:—I was very much interested in the article regarding power from coal, which was published under Readers' Views and Comments in your issue of December 1, 1917. The demand for power is beginning to exceed the supply, and every effort must be put forth to obtain it. When a condition of this kind occurs results may be expected in improving the efficiency of apparatus used for power generation.

With the present steam plants little more efficiency can be expected, except in the smaller plants. It is generally true that the small plant, up to 5,000 kw., as a rule, operates inefficiently. Much is being done to improve this, and it is probable that the next year will see great improvements in the average small plant. Increase of pressure and superheat over the existing standards, for these are more or less standard, will result in improvements in efficiencies of probably 10 to 12 per cent. The difficulties are more of a practical nature than otherwise, but the turbine and boiler builders are ready to make any reasonable increase.

In the system presented in the above named article it appears to me that thermal efficiency will be low because the temperature of the gases leaving the turbine will be high, and the expansion will not be as complete as with the steam turbine. Removal of the tar, which is a combustible, and production of ammonia, which requires the combining of nitrogen and hydrogen, will also tend to reduce the thermal efficiency. The inefficiency of the air compressors will be to some extent compensated for by using the cooling water in the steam boiler. This will also apply to the cooling water for the turbine bearings, and the other water-cooled parts. It is also probable that more steam will be generated than will be needed for the production of gas, since the heat content of the gas will be less than that of the steam. It is my opinion that, when all of the different conditions are thoroughly analyzed, it will be found that the gas engine of the reciprocating type is better adapted to transform the chemical energy of the gas into mechanical or electrical energy.

Reference may also be made to the mercury vapor boiler, but this would probably be too costly for electrochemical work.

A steam-power plant using turbines, proper temperatures, and the suitable apparatus to obtain maximum economy, when placed so that coal can be obtained at low cost, and supplied with an ample supply of cooling water, will, when operated with load factors characteristic of the electrochemical industries, supply power at a cost comparing with the best water-power rates.

G. H. F.

Tug River Elec. Co.,  
Williamson, W. Va.

**Canadian. Metal Production.**—The Canadian Department of Mines estimates the production of metals from Canadian ores for 1917 as follows: Copper, 113,000,000 lb.; nickel, 84,800,000 lb.; lead, 56,700,000 lb.; zinc, 31,000,000 lb.; gold, 17,000,000 oz.; silver, 23,500,000 oz. About 1,186,000 short tons of pig iron were produced and 1,735,000 tons of steel ingots and castings. The production of gold, silver, copper and coal was less than in 1916. The others mentioned were greater.

## A New Water-Power Program in Congress

RECENT important developments in Washington indicate that the administration proposes to accomplish something definite in the development of the water power of the country. For several years past there have been independent programs in the House and Senate covering the development of water power on the public domain and on navigable streams, but due to a lack of co-ordination of the several governmental departments involved, nothing of consequence has resulted. Senate and House apparently have taken irreconcilable positions in the past. Both have passed measures, but neither has been able to agree with the other.

A part of the trouble is due to the complexity of our administration of internal affairs. The public domain is under the control of the Secretary of the Interior, except for forest reserves, which are controlled by the Secretary of Agriculture. Navigable streams, on the other hand, are under the control of the Secretary of War. Hitherto the attempt has been made to pass separate measures pertaining to water power on navigable streams and on the public domain, but the present effort is directed toward a co-ordination of the interests of the three departments.

On Jan. 4 the President held a conference with members of various committees of the House of Representatives, at which the passage of water-power legislation was urged. The personnel of the conferees is significant of the plan to harmonize the several factors concerned. Present at the conference were Thetus W. Sims, chairman of the House Committee on Interstate and Foreign Commerce, who has recently succeeded Judge Adamson in that position; Scott Ferris of Oklahoma, chairman of the House Public Lands Committee; Asbury F. Lever of South Carolina, chairman of the House Agricultural Committee, and Edward W. Pou of North Carolina, chairman of the House Rules Committee, as well as Finis J. Garrett, the ranking member of the House Rules Committee.

The President committed to the care of Representative Pou a copy of a new water-power bill, which will be known as the Administration bill, which attempts to co-ordinate water-power legislation proposed for several years past in both Houses of Congress not only on the public domain but in navigable streams and national forests. The result of the White House conference, it is authoritatively stated in Washington, will be that the House Rules Committee will bring in a rule peremptorily requiring the House of Representatives to vote on and pass water-power legislation at an early date.

The bill was drawn by Gen. Black and Col. Keller, of the Army Engineer Corps, representing the War Department; Edward C. Finney, water-power expert for Secretary Lane, and former Representative Lathrop Brown of New York, now a special assistant to Secretary Lane, representing the Interior Department, and O. C. Merrill of the Forest Service, representing the Agricultural Department, who compiled, several years ago, a mammoth report on water-power companies, their banking affiliations, etc.

### PROVISIONS OF THE ADMINISTRATION BILL

Although most of the delay in water-power legislation has been due to Congress, some of it has been due

to opposing views held by members of the Cabinet. These views have now been reconciled in the new Administration Bill, which provides for a Federal Power Commission, to be composed of three cabinet officers—Secretary of the Interior, Secretary of Agriculture and Secretary of War. It provides for an executive officer of the commission, who shall be appointed by the President for a term of five years. It provides for the payment of rentals of not less than 10 cents per horsepower per annum, a feature to which there has never been objection of consequence by any interest. The commission is empowered to grant licenses to develop water power on public lands and navigable streams for a term of fifty years. At the end of the license period the licensee upon application for a new license shall remain in undisturbed possession until the proposed commission shall have done one of three things: First, issue a new license under laws at that time applicable; second, give license to a new licensee who shall pay for the original fair value of the property; or, third, take the property over upon paying for its fair value. Fair value is defined to include actual cost of property taken plus severance damages for all property not taken over and damaged by reason of severance. Fair value does not include any allowance for enhancement of values on land or water rights granted by the United States, or good-will, going value or prospective revenues. The bill provides for alteration, amendment or repeal by Congress, which expressly reserves such rights, but in case of alteration, amendment or repeal such shall not extend to the licensees who have exercised rights, or spent money under the bill.

At the presidential conference it was agreed that a committee of five members each from the House Committees on Interstate and Foreign Commerce, Agriculture, and Public Lands, fifteen in all, should be created to compose differences as to the various bills which have been under consideration heretofore in the House and to bring together the radical and the more moderate views as to water-power development. The Committee of Fifteen, it is felt in Washington, will be materially aided in its labors by the fact that after mature deliberation, advice and conference, President Wilson himself has presented a bill upon which he believes all can agree.

### THE SENATE'S SHIELDS BILL

What is to take place in regard to water-power legislation in the Senate is not yet known, as that body passed the Shields bill on Dec. 14. This measure deals only with the development of water power on navigable streams, and has no reference to water power on public lands. The latter is in the hands of a separate Senate committee. The principal objects of the Shields bill are thus summarized by Senator Jones of Washington:

1. For the improvement of the navigation of rivers without cost to the government in connection with dams constructed for hydroelectric purposes in navigable streams.
2. For grants by the Secretary of War of authority to private parties for the construction and maintenance of such dams when navigation facilities can be improved thereby, such authority to extend for fifty years and until the property necessary for such a development is taken over and just compensation paid for it either by the government or a duly authorized new grantee.
3. For diligent construction, completion and operation of such dams, subject to market conditions.



4. For the construction by the grantee of suitable locks, without cost to the government, when required by the Secretary of War.

5. For payment to the government by the grantee of the cost of any investigation necessary to the issuing of the grant and the cost of such supervision of construction as may be necessary; and also the payment by the grantee of reasonable charges for benefits resulting from headwater improvements installed by the government and payment to the government of a reasonable price for the use of any public land taken.

6. For the regulation of the rates and service of the grantee by state authority, or, if the business is interstate, by the Interstate Commerce Commission, thereby assuring to consumers efficient service and fair, just and reasonable rates.

7. For reserving to the state authority over the waters and water powers subject to the paramount power of Congress over navigation, and for reserving also all the taxing powers of the states in relation to the properties.

8. For uniform accounting and examination of the books of grantees by the Secretary of War.

9. For leasing under similar conditions the right to utilize surplus water generated at dams constructed by the government.

Senators in charge of water-power legislation in the upper house also are expecting to have White House conferences, and it seems certain that the Administration bill will be introduced in the Senate or that its provisions will come before a Senate Committee in some form, so that when the House passes the Administration bill there may be a conference between the House and the Senate. This will give opportunity to compose the differences between the Administration bill, the Shields bill already passed by the Senate, and the provisions of any measure relating to the public lands which may come from the lands committee of the Senate.

### Award of Medal at Annual Meeting of Mining & Metallurgical Society of America

The annual meeting of the Mining & Metallurgical Society of America was held at the Engineers' Club, New York City, on Jan. 8, 1917. At the afternoon session the following officers were elected: President, W. R. Ingalls; vice-president, J. Parke Channing; secretary-treasurer, L. D. Hunton; members of council, F. W. Bradley, J. V. N. Dorr, J. R. Finlay, Pope Yeatman, R. C. Gemmell.

Honorary membership in the Society was conferred on Dr. James Douglass and Prof. James F. Kemp.

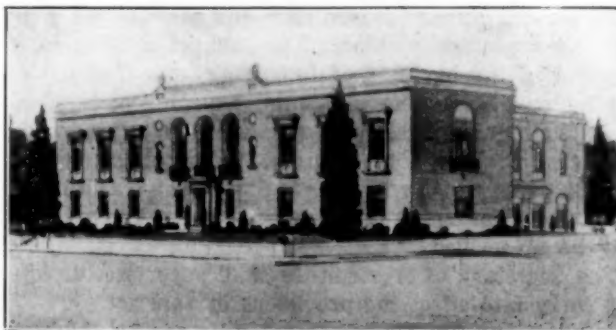
The gold medal of the Society was awarded to Pope Yeatman for distinguished service in the administration of mines.

At the evening session there was some discussion of the surtax on professional incomes as imposed by the War Revenue Act, and a motion was passed declaring it to be the sense of the meeting that the surtax is inequitable and unjust. This action was communicated to the Engineering Council for such action as it might deem wise.

Following the transaction of business the Society listened to informal talks on conditions in Russia by J. P. Hutchins and F. W. Draper. Both of these engineers were able to speak from personal knowledge of events as observed during residence in Russia. Mr. Draper told the story of his experience in bringing from Russia to the United States over 20,000 oz. of platinum for the use of our Government, a task which he had only recently completed.

### New Home of Dayton Engineers' Club

The Engineers' Club of Dayton, Ohio, comprising about 300 engineers in all fields of activity, has completed a handsome new club house at Monument Avenue and Jefferson Street, facing the river, and convenient to the center of the city. It is in keeping with the progressive spirit of the city, and is three stories high, facing 150 ft. on Monument Avenue and 125 ft.



NEW HOME OF DAYTON ENGINEERS' CLUB

on Jefferson St. The first floor has a ladies' room, billiard and game room, large main dining room, and small private dining rooms. On the second floor is a large auditorium, a library, and lounging room. On the third floor are bedrooms.

The club will be dedicated on Saturday afternoon and evening, Feb. 2. Invitations are being sent out throughout the Miami Valley. Col. E. A. Deeds, chief of the Aircraft Production Board, is president of the club, and Mr. C. F. Kettering vice-president.

### Program of New York Meeting of A. I. M. E.

The 116th meeting of the American Institute of Mining Engineers will be held in New York from Monday, Feb. 18, to Thursday, Feb. 21 inclusive. The committee on arrangements consists of J. E. Johnson, Jr., chairman; Bradley Stoughton, vice-chairman; Ralph W. Deacon, J. V. N. Dorr, L. W. Francis, Mrs. S. J. Jennings, A. R. Ledoux, F. T. Rubidge, E. M. Shipp, G. D. Van Arsdale and A. L. Walker. The summarized program follows:

Monday, Feb. 18:

9 a. m. to 5 p. m., registration at Institute headquarters.

10 a. m. and 2 p. m., technical sessions.

12.30 p. m., luncheon at Engineering Societies' Building.

8.30 p. m., war smoker.

Tuesday, Feb. 19:

10 a. m. and 2 p. m., annual business meeting and technical sessions.

12.30 p. m., luncheon at Engineering Societies' Building.

8.30 p. m., announcement later.

Wednesday, Feb. 20:

10 a. m. and 2 p. m., technical sessions.

12.30 p. m., luncheon in Engineering Societies' Building.

7 p. m., "Hoover" dinner at Hotel Biltmore.

Thursday, Feb. 21:

All-day excursion to Princeton to visit aviation field. An attractive program is being prepared for the ladies.

## Licenses Required to Handle Ammonia Products

A proclamation has been issued by the President requiring the licensing of the importation, manufacture, storage and distribution of the following necessities: Ammonia, ammoniacal liquors, and ammonium sulphate from whatever source produced. The proclamation continues as follows:

All persons, firms, corporations, and associations (except those specifically exempted by said act of Congress) engaged in the business of importing, manufacturing, storing or distributing ammonia, ammoniacal liquors, or ammonium sulphate from whatever source produced, are hereby required to secure a license on or before Jan. 21, 1918, which will be issued under such rules and regulations governing the conduct of the business as may be prescribed.

The Secretary of Agriculture shall supervise, direct, and carry into effect the provisions of said act.

Applications for licenses must be made to the law department, license division, United States Food Administration, Washington, D. C., upon forms prepared for that purpose.

## Employees' Responsibility on Secret Processes

An interesting and important decision was recently handed down by the Supreme Court of the United States in the case of *Walter E. Masland vs. E. I. du Pont de Nemours & Co.* The former was formerly in the employ of the du Pont company and the company sought to restrain him from using or disclosing secret processes in artificial leather manufacture which it was claimed he had learned while in their employ. He claimed that the process was not secret and that he did not expect to use information gained in confidence. He was prevented by the court, however, from revealing to experts or other witnesses the data claimed as secret by the du Pont Company. The Circuit Court of Appeals reversed this decision however, but it was upheld by the Supreme Court. Their statement follows:

"The case has been considered as presenting a conflict between a right of property and a right to make a full defense, and it is said that if the disclosure is forbidden to one who denies that there is a trade secret, the merits of his defense are adjudged against him before he has a chance to be heard or to prove his case. We approach the question somewhat differently. The word property as applied to trade-marks and trade secrets is an unanalyzed expression of certain secondary consequences of the primary fact that the law makes some rudimentary requirements of good faith. Whether the plaintiffs have any valuable secret or not, the defendant knows the facts, whatever they are, through a special confidence that he accepted. The property may be denied, but the confidence cannot be. Therefore, the starting point for the present matter is not property or due process of law, but that the defendant stood in confidential relations with the plaintiffs, or one of them. These have given place to hostility, and the first thing to be made sure of is that the defendant shall not fraudulently abuse the trust reposed in him. It is the usual incident of confidential relations. If there is any disadvantage in the fact that he knew the plaintiffs' secrets, he must take the burden with the good.

"The injunctions asked by the plaintiffs forbade only the disclosure of processes claimed by them, including the disclosure to experts or witnesses produced during the taking of proofs—but excepting the defendant's counsel. Some broader and ambiguous words that crept into the decree, seemingly by mistake, may be taken as stricken out and left on one side. This injunction would not prevent the

defendant from directing questions that should bring out whatever public facts were nearest to the alleged secrets. Indeed, it is hard to see why it does not leave the plaintiff's rights somewhat illusory. No very clear ground as yet has been shown for going farther. But the judge who tries the case will know the secrets, and if in his opinion and discretion it should be advisable and necessary to take in others, nothing will prevent his doing so. It will be understood that if, in the opinion of the trial judge, it is or should become necessary to reveal the secrets to others, it will rest in the judge's discretion to determine whether, to whom, and under what precautions, the revelations should be made."

## Fifth National Foreign Trade Convention

The National Foreign Trade Council has called the Fifth National Foreign Trade Convention to meet at the Gibson Hotel, Cincinnati, on Thursday, Friday and Saturday, Feb. 7, 8, 9. The part of foreign trade in winning the war will be the theme of the convention.

All Americans engaged in, or desirous of entering overseas commerce, and especially all chambers of commerce, boards of trade, and other commercial and industrial organizations, as well as firms and individuals, are invited to take part, individually or by appointment of delegates, in this convention.

Approximately one-half of the time of the convention will be given to the presentation of prepared papers and reports dealing with one or another of the numerous phases of this great convention theme. The remainder will be devoted to group sessions for the intensive discussion of concrete problems, under the leadership of specially qualified experts. The departments of government dealing with foreign trade matters, including the War Trade Board, and other war organizations, will lend their hearty co-operation.

The offices of the council are at No. 1 Hanover Square, New York.

## Technical Association of Pulp and Paper Industry

The annual meeting of the association will be held at the Waldorf-Astoria in New York on Tuesday, Wednesday and Thursday, Feb. 5, 6 and 7. The executive committee will meet on Tuesday and a general meeting will be held on Wednesday morning. On Wednesday afternoon separate sectional meetings will be held on "Acid Sulphite Manufacture and Problems Relating to Engine Sizing." The annual dinner will be held Wednesday evening.

## Société de Chimie Industrielle

The New York Section of the Société de Chimie Industrielle will meet for organization immediately following the meeting of the British Society of Chemical Industry at the Chemists' Club, 50 East Forty-first Street, at 8.15 p. m., on Friday evening, Jan. 18. All those interested are earnestly requested to be present.

**By-products from Garbage.**—The Chicago Chemical Bulletin says that New York City's garbage, by treatment in a \$3,000,000 recovery plant of the latest type (so-called Cobwell process, chemical) on Staten Island, yields the following commercial products: Grease for 70,000,000 cakes of soap, 1500 tons of nitrogen, 2000 tons of phosphoric acid, 500 tons of potash. The increased recoveries amount to 25 per cent more than under the best previous reduction methods used for New York's garbage.



## Italian Leucitic Lavas as a Source of Potash

BY HENRY S. WASHINGTON

WITH the present urgent need of potash to replace that which was previously sent out from Germany, other sources of supply of this substance assume great importance. In recent publications of the United States Geological Survey, Phalen<sup>1</sup> and Gale<sup>2</sup> describe the different sources in considerable detail, though confining themselves chiefly to those in the United States. While some of these sources appear to be promising, at least under present conditions, others, even at maximum possible utilization, can furnish but a small fraction of what is needed.

The igneous rocks of the earth's crust contain, on an average, about 3 per cent of potash ( $K_2O$ ), some of them running as high as over 10 per cent. It is upon these, and especially those richest in potash, that the world will ultimately have to depend in great part for its supply.<sup>3</sup> At the present time, it would seem, no satisfactory practicable method has yet been devised for the extraction of potash from these rocks on a large commercial scale which could compete successfully with the German potash deposits in normal times. The solution of this important problem must be left to the future, and the subject will not be considered here.<sup>4</sup> It will, however, not be amiss to call the attention of those interested in potash to what may justly be considered as the greatest accumulation of very highly potash-rich igneous rocks known to exist on the earth's surface—the leucitic lavas of the Italian volcanoes.

Well known as they are to geologists, it is somewhat surprising that little or no mention is made of these rocks by writers dealing with sources of potash. Phalen, Gale, and Pogue, in the papers already cited, when enumerating the silicates possibly capable of yielding commercial amounts of potash, discuss feldspar, sericite, glauconite, and the lavas of the Leucite Hills in Wyoming, but make no mention of those of Italy, presumably because they were dealing more especially with possible domestic sources of supply. The Italian lavas are briefly alluded to by Schultz and Cross<sup>5</sup> in a paper devoted to the Wyoming rocks. Both De Launay<sup>6</sup> and Lindgren<sup>7</sup> dismiss leucitic rocks from consideration as a practicable source of supply because of the difficulty of extraction. Both of these authors, however, were writing before the present highly abnormal conditions obtained.

In their own country the Italian lavas have received some attention. Monaco<sup>8</sup> has published several short papers describing the results of experiments in treat-

ing the rock powders with dilute solutions, in simulation of the action of soil fluids, a small amount of potash being extracted. Moderni,<sup>9</sup> prior to the outbreak of the war, published a paper in which he briefly describes the different Italian volcanoes that furnish leucitic rocks, with descriptions of the more important lava flows, and their possible utilization as a source of potash.

### LEUCITIC ROCKS

It would not be appropriate here to go into detailed, technical descriptions of the Italian leucitic rocks,<sup>10</sup> but it may be well to devote a few words to them, as the use of some technical terms is necessary in describing the volcanoes and their rocks.

The minerals which are especially important for their potash content in the Italian rocks are two in number, both silicates of potash and alumina, but with different ratios of silica to the other two oxides.

### LEUCITE

The most important, because it is the richer in potash and the more abundant in these lavas, is leucite. Although met with in volcanic lavas in various localities in different parts of the world, leucite is rather a rare mineral, except along the line of the Italian volcanoes, where it may be said to be characteristic of the lavas. It is white or light grayish, with a dull luster, and almost invariably in well formed crystals which, though bounded by crystal faces, are spherical in general form. Theoretically leucite ( $KAlSi_3O_8$ ) contains 21.5 per cent of potash ( $K_2O$ ), with 23.5 of alumina ( $Al_2O_3$ ) and 55 of silica ( $SiO_2$ ), but analyses show that the natural crystals actually contain about 19.5 of potash, the smaller percentage being due to the presence of small amounts of soda and other impurities. The fresh mineral contains no water. Leucite is readily decomposed by acids, the potash and alumina going into solution, and the silica being left in granular form. The Italian leucite crystals vary much in size, from that of a tennis ball or larger, through sizes of a walnut or a pea (these being much more common), down to microscopic dimensions, so that often to the naked eye the rock does not appear to contain leucite. In places, especially among some of the incoherent tuffs, there are masses made up almost wholly of loose leucite crystals, generally of medium sizes.

### ORTHOCLASE

The other mineral, orthoclase (potash feldspar) is much less abundant and of less importance than leucite in most of the Italian leucitic lavas. Elsewhere, throughout the world, it is much the more abundant and important of the two. It is typically white, with a

<sup>1</sup>W. C. Phalen, Potash Salts, 1915, U. S. Geol. Surv., Mineral Resources, 1915, II (12), pp. 95-133, 1916.

<sup>2</sup>H. S. Gale, Potash in 1916, U. S. Geol. Surv., Mineral Resources, 1916, II, pp. 73-171, 1917.

<sup>3</sup>Cf. J. E. Pogue, Fertilizers, U. S. Nat. Museum, Bull. 102, Part 2, p. 18, 1917.

<sup>4</sup>The extraction of potash from silicate rocks will be discussed in a paper that is to appear shortly.

<sup>5</sup>A. R. Schultz and W. Cross, Potash-bearing Rocks of the Leucite Hills, U. S. Geol. Surv., Bull. 512, 1912.

<sup>6</sup>E. De Launay, Gîtes Minéraux et Métallifères. Paris, 1913, II, p. 195.

<sup>7</sup>W. Lindgren, Mineral Deposits, New York, 1913, p. 243.

<sup>8</sup>E. Monaco, Sull' Impiego delle Rocce Leucitiche, Le Stazioni sperimentali agrarie italiane, XXXVI, p. 577, 1903; ditto, XXXVII, p. 1031, 1904; ditto, XXXIX, p. 340, 1906.

<sup>9</sup>P. Moderni, Le Leucitiche dei Vulcani Italiani, L'Industria Chimica, Mineraria e Metallurgica, I, 1914.

<sup>10</sup>For complete, petrographic descriptions and analyses of the various types see H. S. Washington, The Roman Comagmatic Region, Publication No. 57, Carnegie Institution of Washington, 1906. Descriptions will also be found in most of the papers cited later in connection with each volcano.

vitreous luster, and cleaves readily in two directions. When crystallized the crystals very frequently have a tabular form. Theoretically pure orthoclase ( $\text{KAlSi}_3\text{O}_8$ ) contains 16.9 per cent of potash, with 18.4 of alumina and 64.7 of silica. Actually, however, all the "orthoclase" of the Italian volcanoes (as well as nearly all of it elsewhere), contains varying, and sometimes large, amounts of soda feldspar (albite), so that the actual amount of potash present varies from less than 7 to about 10 per cent. In a very few Italian leucitic rocks the amount of orthoclase exceeds that of the leucite, but in the great majority it is much less, and in a large number of leucitic lavas it is wholly absent.

The chief minerals associated with these in the Italian lavas are soda-lime feldspars (silicates of alumina, soda and lime, of variable composition), and augite (silicates of iron, lime, magnesia, and a little alumina). In some of the lavas either or both of these may be present in amounts equal to that of the leucite. Other minerals occur as rock constituents in these lavas, such as olivine, nephelite, sodalite, magnetite, and apatite, but usually only in very minor amounts, so that, in general, they would not affect the percentage or the practical extraction of potash.

The leucitic rocks of which these minerals are the constituents must be described very succinctly. They may be broadly divided into three main groups, called respectively leucite trachytes, leucite tephrites, and leucitites.

#### LEUCITE TRACHYTES

The leucite trachytes are light gray and generally quite compact. They are composed essentially of sodic orthoclase and leucite, the former in some cases more abundant than the latter, with very subordinate amounts of soda-lime feldspar, augite, and other minerals. In these rocks the leucite crystals frequently attain large dimensions, while, in general, the orthoclase exists for the most part in microscopic size. As a class they are the richest in potash, averaging about 9.68 per cent  $\text{K}_2\text{O}$ , and some of them showing percentages of 10.40, 10.47, 10.49 and 10.63.

#### LEUCITE TEPHRITES

The leucite tephrites are dark gray to nearly black, and are usually compact. They are composed essentially of leucite, augite and soda-lime feldspar, with very small amounts of other minerals. Few of them show leucites visible to the naked eye, and then the crystals are small. As a usual thing leucite and augite each make up about 30 per cent of the rock, with the feldspar in somewhat less amount. Their potash content varies from about 7.50 to over 8 per cent, and they are much higher in lime, iron and soda, and lower in silica, than the preceding type.

#### LEUCITITES

The leucitites are dense, black, basaltic rocks, which scarcely ever show visible crystals of any sort. They are composed essentially only of leucite and augite, which constitute about 80 per cent or more, with very small amounts of other minerals. Their potash content is about that of the leucite tephrites, though slightly lower as a rule, and otherwise in chemical composition they much resemble these, but minera-

logically and chemically the two types tend to grade into each other.

The average potash content of the Italian leucitic lavas, as shown by 27 complete chemical analyses made by me,<sup>11</sup> embracing representatives of all the types, is 8.72 per cent; while the average for all the lavas of these volcanoes, leucitic and non-leucitic, based on 44 analyses, and taking into account the relative abundance of the various kinds,<sup>12</sup> is 8.31 per cent. No other region of igneous rocks of commensurate, or even far greater, size is known that is so high in potash.

These leucitic lavas form flows that vary greatly in dimensions; up to 20 or more kilometers long and several kilometers broad, where not covered by tuffs, and as thick as 10 or more meters. In a general way it may be said that their exposed portions are from 1 to 5 kilometers in length, by about one or less in breadth, and with an average thickness of from 4 to 5 meters. They frequently show prismatic or platy parting, which facilitates extraction. Many of the flows are extensively quarried for paving blocks, which are commonly used in this part of Italy.

In addition to the lavas which carry leucite there are others at some of the volcanoes that are free from leucite, but contain large amounts of orthoclase or other feldspars. These are trachytes, andesites and basalts. The potash content of the trachytes (orthoclase lavas) varies from about 7.50 to over 9 per cent. The few andesites and basalts contain little potash. There are also very extensive beds of more or less incoherent tuffs, derived from the loose ashes and scorias thrown out by the volcanoes. While some of these are not leucitic, many of them are quite rich in this mineral and contain very considerable percentages of potash.

#### METHODS OF CUBATURE

The method adopted by me for calculating the volumes of the volcanic masses was as follows: As they all have an approximately circular plan, with sides that slope up (more or less regularly) to a circular summit, the form was assumed to be that of a frustum of a cone. The irregularities of the sides, due to erosion or the presence of small, flank eruptions, were disregarded as of negligible magnitude for the rough calculations involved, and they tend more or less to balance each other. No correction was made for the natural concavity of the sides of a volcanic cone, as the error involved is small and is compensated by the lava flows that extend beyond the assumed base.

At the topographically highly irregular Bolsena and Bracciano volcanoes, the base selected was the sedimentary platform on which the volcanic mass rests; while at the more regular Vico, Alban Hills, Rocca Monfina and Vesuvius volcanoes it was assumed to be the lower border of the main cone, where it merges into the nearly horizontal lava flows and sheets of tuff that extend around it. This base would be somewhat above the sedimentary platform, and so the estimated volumes for the lavas of these cones are rather too small. The assumed top circle of the frustum varies with the form of the volcano. At Bolsena, Vico and Bracciano it was assumed to be that of the rim surrounding the central lake or crater, an average height above the base being

<sup>11</sup>H. S. Washington, *The Roman Comagmatic Region*, p. 146.

<sup>12</sup>H. S. Washington, *The Roman Comagmatic Region*, p. 174.



calculated for this, and the volume occupied by the central cavity being subtracted. At the Alban Hills, Rocca Monfina and Vesuvius, where, of the original early crater wall there remains only a semicircular ridge, the top is the approximately circular floor of the crater of the first eruptive period, inside the semicircular ridge. The volume of this ridge, together with that of the latest small, terminal cone (except at Rocca Monfina) is added to that of the main cone.

The formula used was that for a frustum of a cone:

$$V = \frac{1}{3}\pi h(a^2 + ab + b^2),$$

where  $h$  is the height from base to top, and  $a$  and  $b$  the radii of the base and top circles.

V. Sabatini<sup>15</sup> adopted a different method for the cubature of the Alban Hills and Vico, though, as his object was the calculation of the total existing material ejected; his bases are more extensive than mine, especially at the former volcano. The areas included by the successive 50-meter contour lines were measured with a planimeter, and the volumes of a series of annular cylinders were calculated, whose bases were these areas and whose heights were about the mean altitudes.

#### THE VOLCANOES

The Italian volcanoes<sup>16</sup> that are characterized by leucitic lavas are seven in number, forming a row that extends from Orvieto at the northwest to Naples at the southeast (a distance of about 300 kilometers), parallel to and quite near the west coast of the Italian peninsula. Vesuvius alone is active, the others having been long extinct, and some of them have largely lost their original forms through erosion.

#### BOLSENA VOLCANO

The most northerly and the largest is that known as the Bolsena Volcano<sup>17</sup>, which lies just west of Orvieto and some 90 kilometers northwest of Rome. It is the earliest in geological age of the seven, and is considered by some to be the remains of one huge volcano, while others consider it to be a complex of four moderate sized cones. Into this question we need not go. The total area covered by its volcanic rocks is about 2289 square kilometers.<sup>18</sup>

In the center is an elliptical lake, Lake Bolsena, 305 m. above sea level, with an area of about 115 square kilometers and a maximum depth of 146 meters. Surrounding this is a broad girdle of hills, made up of lavas and tuffs, with numerous, radiating erosion valleys and lava flows, extending to the borders of the area. The slope, in general, is upward from the borders of the mass toward the hills encircling the lake (these having an average altitude of about 300 meters above its level). But the topography is distinctly irregular

and largely determined in details by the erosion of the various cones that compose the group. The diameter of the almost circular igneous area is about 40 kilometers, and the average altitude of the sedimentary base, though somewhat variable, may be taken as about 230 meters above sea level.

Apart from a few flows of non-leucitic rocks (andesites and trachytes), which cannot make up 10 per cent of the lavas, the rocks are highly leucitic lavas and their tuffs. Incidentally, it may be mentioned that the lavas of the Bolsena Volcano are more varied than those of almost any of the other volcanoes along the line. From the specimens collected by myself, and from the descriptions by others, though a complete study has not yet been made, it would appear that, of the lavas, leucite tephrites are somewhat the most abundant, leucite trachytes almost as much so, and leucitites in less amount. It would also appear that leucite trachytes predominate in the northwestern sector of the area, leucite tephrites northeast and southwest of the lake, and leucitites to the southeast.

So far as I am aware, no attempt has been made to calculate the volume of the Bolsena Volcano or of its lava flows—a problem which, indeed, can only be solved in a very rough way, because of the irregular topography. The result will, at least, give the order of magnitude and a rough approximation of the volumes involved. From the data furnished by the excellent Italian topographic maps, some of which have been given above, we obtain a total volume for the present volcanic mass of 178.9 cubic kilometers. Deducting from this the volume occupied by the lake and its basin, 46.2 cubic kilometers, there remains a volume of about 133 cubic kilometers of igneous rocks (lavas and tuffs) now existing above the sedimentary platform of the volcano. It is difficult to estimate the relative amounts of lavas and tuffs, but from my observations in the field it would seem to be reasonable to consider that the lavas form one-tenth of the mass. Of these lavas we may very liberally allow one-tenth for those which are non-leucitic. We thus obtain a final result of about 12 cubic kilometers of leucitic lavas, an estimate that may be considered to be conservative. Assuming that the average specific gravity of the rocks is 2.8, and that the potash content is about 8 per cent, this being based on a number of good analyses and study of my specimens, we arrive at a final total of 2,688,000,000 metric tons of potash ( $K_2O$ ) contained in the leucitic lavas of the Bolsena Volcano.

#### VICO VOLCANO

This volcano<sup>19</sup> lies a few kilometers to the southeast of the Bolsena Volcano, 65 kilometers northwest of Rome, the city of Viterbo being at its north foot. It is one of a pair of volcanoes, but as the other, Monte Ciminó, has poured out no leucitic lavas, this will not be considered here.

The Vico Volcano forms a quite regular cone, much better preserved and simpler than Bolsena. The cone proper has a circular base, at an altitude (average) of about 330 meters above sea level, and with an area of about 350 square kilometers, though extensive, thin beds of tuff extend beyond this. In the center is a nearly circular crater pit, about 9 kilometers in diam-

<sup>15</sup>V. Sabatini, *Vulcano Laziale*, p. 134; *Vulcani Cimini*, p. 269. It may be pertinent to mention that my knowledge of these volcanoes and their lavas is the result of studies in the field and in the laboratory extending over many years.

<sup>16</sup>H. S. Washington, *Italian Petrological Sketches*, Jour. Geol., IV, pp. 541-566, 1896; P. Moderni, *Studio Geologico dei Vulcani Vulsini*, Bollettino Comitato Geologico, 1904, 234 pp., with topographic map 1:100,000. It is to be noted that references to only two or three of the most descriptive papers are given in the case of each volcano, as the literature is far too extensive for full citation here.

<sup>17</sup>In this paper all measurements are given in the metric system, as this is the official system of Italy and all the maps on which the calculations are based are in accordance with it. It will be useful to note the following approximate equivalents:

1 meter	= 39.37 in. or 3.28 ft.
1 kilometer	= 0.62 mile
1 square kilometer	= 0.39 square mile
1 cubic kilometer	= 0.24 cubic mile
1 metric ton	= 2,205 lb. = 1.1 short ton

<sup>18</sup>H. S. Washington, *Italian Petrological Sketches*, Jour. Geol., IV, p. 826, 1896; V. Sabatini, *Vulcani Cimini*, Mem. Carta Geol. Ital., XV, 1912. Geological map, 1:75,000.

eter and 275 meters deep. The ridge surrounding the crater is rather sharp and has an average height above the base of about 450 meters. On the crater floor is a small, solid cone, Monte Venere, which is 320 meters high, near the foot of which is a small, shallow lake.

The lavas of Vico are much more uniform than those of Bolsena. There is a small proportion, less than 10 per cent, of trachytic rocks which, though they contain orthoclase instead of leucite, carry about 9 per cent of potash. Of the other lavas the greater part are leucite trachytes (often with abundant and large leucite crystals), and less leucite tephrites, while leucitites seem to be absent. In potash content the lavas range from 10.47 to 7.47 per cent, with an average of about 9.25.

Because of the fair state of preservation of the originally quite regular cone, the calculation of the volume of this volcano is simpler and susceptible of more accuracy than that of Bolsena. It has already been carried out by Sabatini, whose results will be given presently. Using the data given above, we obtain a total volume for the cone above the sedimentary platform of 83.4 cubic kilometers, to which is to be added 0.6 for the mass of Monte Venere, making a total of 84. From this is to be subtracted the volume of the crater, about 3.5 cubic kilometers, leaving a final volume of volcanic rock of 80.5 cubic kilometers. Assuming, as before, that the lava-flows form about one-tenth of the mass, the average specific gravity as 2.8 and the average potash as 9 per cent, we get a total potash content of 1,668,600,000 metric tons.

Using a somewhat different method, Sabatini<sup>18</sup> obtains a total volume of igneous material above the sedimentary base of 96.3 for both Monte Vico and Monte Cimino. Of these combined masses, according to his figures, Monte Vico makes up 84 per cent, so that his estimate for the Vico Volcano alone would be 80.6 cubic kilometers, a figure in very good agreement with that obtained by me independently, 80.5, using a different method.

#### BRACCIANO VOLCANO

This volcanic area<sup>19</sup> lies south of the preceding one, and about 25 kilometers northwest of Rome. The igneous rocks cover an area of about 1300 square kilometers, and the topography in its general features resembles that of the Bolsena Volcano, but on a somewhat smaller scale. There is a central lake, Lake Bracciano (area 57.5 square kilometers), the circle of hills about it being highest, 440 meters above the lake, on the northwest, and lowest on the south. It would appear that the mass is a complex of small cones, possibly parasitic to a large central one; but erosion has so altered the original forms that decision is difficult. Thus, the topography of the area is very irregular, though in a general way the surface slopes upward toward the hills bordering the lake.

The lavas of this volcano are predominantly leucite tephrites and leucitites, with very few leucite trachytes in the northwestern sector, and a few occurrences of non-leucitic trachytic rocks. Few good analyses of the lavas of this volcano have been made, but these indicate that they have an average potash content of about 9

per cent. One of the leucite trachytes contains 10.49 per cent.

Because of the highly irregular topography any satisfactory or approximately exact calculation of the volume of the igneous mass, and especially of that of the leucitic lavas, is very difficult. I have attempted it in a rough way, using the data of the Italian topographic maps, with the following results, which must be regarded as only a very rough approximation. The total volume of the volcano is about 48 cubic kilometers, from which is to be subtracted the volume of the lake basin (11 cubic kilometers), leaving for the volume of the igneous rocks 37 cubic kilometers. Assuming that the leucitic lavas constitute 10 per cent of this, with a specific gravity of 2.8, and 9 per cent of potash, they would contain 932,400,000 metric tons of  $K_2O$ .

#### ALBAN HILLS

This volcano<sup>20</sup>, also called the Latian Volcano, lies about 13 kilometers southeast of Rome. It forms an isolated conical mass, with the original volcano form fairly well preserved. From a very extensive, very gently sloping base of tuffs, with some long lava flows, the cone proper (having an area at its base of about 345 square kilometers), rises to a circular ridge, with elevations of from 550 to 940 meters above sea level. This incloses the old crater floor, about 10 kilometers in diameter and with an elevation that may be placed at about the 600-meter contour line, the sedimentary base being assumed to be at about 200 meters. In the center rises a small, terminal cone, with the remains of a crater. Several small crater lakes, due to side eruptions, are found on the flanks of the main cone.

The lavas of this volcano are remarkably uniform, leucitites being overwhelmingly predominant, with very rare leucite tephrites. There are no leucite trachytes, or trachytic or andesitic rocks. Tuffs are abundant, but they, especially those that make up the cone proper, are mostly leucitic. Good analyses of these lavas are not numerous, but they indicate that the average potash content is somewhat over 8 per cent.

The cubature of this volcano has been carried out by Sabatini, whose results will be given below. Using the data given above and others derived from study of the map, I obtained the volume for the main cone, above the 200-meter contour line (which is approximately that of the encircling railroads or the lower limit of the area of leucitic tuffs given on Sabatini's map), of 78.5 cubic kilometers. Adding to this the volumes of the small cone, 2 cubic kilometers, and that of the ridge, 2.5 cubic kilometers, we get a total volume of about 83 cubic kilometers. Assuming, as before, that the lavas constitute one-tenth of this, have an average specific gravity of 2.8, with an average potash content of 8 per cent, they would contain some 1,859,200,000 tons of  $K_2O$ .

Sabatini,<sup>21</sup> using the method outlined above, obtained results which, though differing somewhat from mine, are fairly concordant, considering the differences in method. His area at the altitude of 174 meters (the nearest taken by him to my base altitude of 200), is 327 square kilometers, my figure, on the assumption that the base is circular, being 345. The volume of the cone from this 174-meter base to the altitude of 608

<sup>18</sup>V. Sabatini, *Vulcani Cimini*, p. 262, 1912.

<sup>19</sup>H. S. Washington, *Italian Petrological Sketches*, III, Jour. Geol., V, p. 34, 1897; P. Moderni, *Le Bocche Eruttive dei Vulcani Sabatini*, *Bollettino Comitato Geologico Italiano*, p. 1, 1896. Topographic map, 1:100,000.

<sup>20</sup>V. Sabatini, *Vulcani Laziale*, *Mem. Carta Geol. Ital.*, X, 1900. Geological map, 1:75,000.

<sup>21</sup>V. Sabatini, *Vulcano Laziale*, p. 134.



meters is 93 cubic kilometers, my result from the 200 to the 600-meter levels being 78.5.

#### HERNICAN VOLCANOES

In the valley of the Sacco River, about 65 kilometers southeast of Rome (the country of the ancient Hernici), are the remains of about eight small volcanic cones.<sup>22</sup> These are composed almost entirely of leucite tephrites and their tuffs, the lavas containing about 8 per cent of potash. They might contain in all something like 100,000,000 tons of potash; but the amount is so small and their distance from industrial centers is so great that they need not be considered in the present connection.

#### ROCCA MONFINA VOLCANO

This volcano<sup>23</sup> lies about 50 kilometers north of Naples, between the Garigliano and Volturno Rivers. Its igneous rocks cover an area of about 225 square kilometers. In general structure this volcanic mass much resembles Vico, the Alban Hills and Vesuvius, though it is not quite as well preserved. There is a large main cone, surmounted by a semicircular ridge, which reaches on the west a height of 926 meters above the sea, the original ridge being worn down to a series of low hills on the east. The original circular crater floor, something like 400 meters above the base,<sup>24</sup> has a diameter of about 6 kilometers. From the center of this rises a small cone, Monte Santa Croce, of non-leucitic andesite.

The lavas of this volcano are almost as varied in their characters as those of Bolsena. There are some flows of non-leucitic lavas (basalts, andesites, trachytes), but the leucitic lavas preponderate very greatly, and would seem to be rather more abundant relatively to the tuffs than in the other volcanoes. All three kinds are found, leucite tephrites being the most abundant, with leucitites and leucite trachytes probably in the order named. The last are especially noteworthy, as are some of the tuffs, for the abundance of very large leucite crystals. There are but few satisfactory analyses of the lavas of this volcano, but a conservative estimate would place the average potash content at at least 9 per cent. One leucite trachyte contains 10.64 per cent, the highest figure for potash obtained in the Italian lavas.

In the absence of adequate topographic data, the cubature of this volcano must be regarded as but roughly approximate. It is estimated that the cone, from the base to the crater floor, has a volume of about 40.5 cubic kilometers, to which is to be added the volume of the semicircular ridge, approximately 2.5, making a total of 43 cubic kilometers. Assuming that the lavas are at least one-tenth of this, and the non-leucitic flows<sup>25</sup> one-tenth of the lavas, there is left a volume of about 4 cubic kilometers of leucitic lava flows. With an average specific gravity of 2.8, and a potash content of 9 per cent, these would contain 1,008,000,000

tons of  $K_2O$ , a figure which, by comparison with the analogous volcanoes of Vico and the Alban Hills, I consider to be much below the true one.

#### VESUVIUS

This, the only active volcano of the series,<sup>26</sup> lying some 10 kilometers east of Naples, is so well known that it calls for little description. Leaving out of account the extensive beds of tuff that cover the surrounding Campagna, the area of the base<sup>27</sup> of the cone is about 80 square kilometers, the average altitude of the boundary being about 150 meters above the sea. The cone slopes quite regularly up to the Pedimentina, a circular plateau at an altitude of 600 to 800 meters. This is bounded on the north by the narrow semicircular ridge of Monte Somma, which rises to a maximum height of 1132 meters above sea level. Near the center of the Pedimentina is the modern cone, about 2 kilometers across at its base and 400 meters high. The present crater at the summit of this cone is about 1000 meters in diameter and 320 meters deep.

On the whole, the lavas of Vesuvius are very uniform and are all leucitic. With the exception of some of the flows of Somma and a few early beds of pumice, they may be referred to the leucite tephrites with scarcely an exception. Judging from observations on the inner walls of Somma and of the active crater, lava-flows and dikes are quite abundant as compared with the tuffs and ashes. The average potash content of the Vesuvius lavas is between 7.50 and 8.00 per cent.

Well known and much studied as is Vesuvius, it is rather remarkable that no attempt appears in its literature to calculate its volume. Using the data given above, supplemented by study of the topographic map, it is estimated that the main cone, from the base of 150 meters to the Pedimentina, has a volume of 20 cubic kilometers. To this must be added the volume of the Somma ridge above the Atrio level, 0.5, and that of the modern cone, 0.7 cubic kilometers, making in all a total of at least 21 cubic kilometers. Considering the relative abundance of the lava flows and dikes, and the fact that most of the ashes and scorias are high in potash, it would seem reasonable to assume that the lavas make up about one-seventh of the mass. On this basis, and with an average specific gravity of 2.8, and potash content of 7.5 per cent, we obtain 8,400,000,000 tons of leucitic lava, containing 630,000,000 tons of potash.

Immediately west of Naples is a volcanic district, the Phlegrean Fields, which covers about 150 square kilometers, and in which are found about twenty-six small cones. These are mostly of non-leucitic tuffs, with some lava flows, all of them non-leucitic orthoclase trachytes. They average about 8 per cent in potash content.

#### RECAPITULATION

For convenience the various data set forth in the preceding pages are here tabulated:

<sup>22</sup>W. Branco, *I Vulcani degli Ernici*, Neues Jahrbuch für Mineralogie, 1877, p. 561. Geological map, 1: 86,400; C. Viola, Osservazioni Geologiche fatte nella Valle del Sacco, Boll. Com. Geol. Ital., 1896, p. 4, map.

<sup>23</sup>L. Bucca, *Il Monte di Rocca Monfina*, Boll. Com. Geol. Ital., 1886, p. 245; P. Moderni, *Note Geologiche sul Gruppo Vulcanico di Rocca Monfina*, Boll. Com. Geol. Ital., 1887, p. 74. Geological map, 1:100,000. H. S. Washington, *Italian Petrological Sketches*, IV, Jour. Geol., V, p. 34, 1897.

<sup>24</sup>As my copies of the Italian topographic maps are not available at the time of writing, this altitude is not certain, but, from analogy with the other volcanoes, is believed to be a conservative estimate.

<sup>25</sup>The mass of Monte Santa Croce is disregarded in the calculations.

<sup>26</sup>J. Phillips, *Vesuvius*, Oxford, 1869, 355 pp.; J. L. Lobley, *Mount Vesuvius*, London, 1889, 400 pp. (both are popular descriptions); H. J. Johnston-Lavis, *The Geology of Monte Somma and Vesuvius*, Quart. Jour. Geol. Soc. Lond., XL, p. 35, 1884; A. Lacroix, *L'Eruption du Vesuve* (April, 1906), Paris, 1907, 169 pp.; Topographic Map, Scale 1: 75,000, Istituto Geografico Militare, 1908.

<sup>27</sup>The boundary of this is approximately the highway that encircles Vesuvius, passing through Pollena, Somma, Ottalano, Avini, Bosco Tre Case, and the railroad just above Torre del Greco and Portici.

SUMMARY OF DATA AS TO POTASH IN LEUCITIC LAVAS OF ITALIAN VOLCANOES

Volcano	Area of Base Km <sup>2</sup>	Alt. of Base* Met	Average Height Main Cone† Met	Total Volume‡ Volcano Km <sup>3</sup>	Leucitic Lavas Metric Tons	Per Cent K <sub>2</sub> O	Amount of Potash Metric Tons
Bolsena.....	2289	230	350	133	33,600,000,000	8	2,688,000,000
Vico.....	350	330	450	80.5	18,540,000,000	9	1,668,600,000
Bracciano.....	1300	220	200	37	10,360,000,000	9	932,400,000
Alban Hills.....	345	300	400	83	23,240,000,000	8	1,859,200,000
Rocca Monfina.....	225	300	400	43	11,200,000,000	9	1,008,000,000
Vesuvius.....	80	150	550	21	8,400,000,000	7.5	630,000,000
Total.....	.....	.....	.....	.....	105,340,000,000	.....	5,786,200,000

\*Above sea-level. †Above base. ‡Corrected for crater, etc.

In considering these figures it must be borne in mind that in nearly, if not quite, all respects they are thought to be under, rather than over, estimates. This, on the following grounds. The dimensions and volumes of the calculated volcanic masses are those of the main cones, and, except in the cases of Bolsena and Bracciano, disregard portions of flows extending beyond the limits of the bases selected. The assigned altitude of the base above sea-level has been liberally high, and the average height of the cone above it is regarded as, in general, rather under than above the truth. The choice of figures for specific gravity and potash percentage have also been moderate. It is thought that the only factor that may be possibly too high is the assumption that the lavas constitute one-tenth of the volcanic mass. This, however, is based on rather extensive observations in the field, as well as on consideration of the fact that in the mass of the main cone, which alone has been considered in the preceding calculations, the relative amount of lava to tuffs and scoria is always very much greater than in the outlying or surficial portions of the volcano. This is well seen in the walls of Somma, the crater of Vesuvius, the walls of Val del Bove at Etna, in the crater of this volcano, and elsewhere. Even if somewhat high, it is to a certain extent compensated by the disregarding of the tuffs and scorias in the calculations, though many of these contain large percentages of potash. It would, therefore, be reasonable to suppose that the row of Italian volcanoes contains at least some 10,000,000,000 tons of potash (K<sub>2</sub>O). It may be of interest to remark that the average annual consumption of potash in the United States for the ten years from 1905 to 1914 was almost exactly 200,000 short tons,<sup>2</sup> so that these volcanoes represent, "on paper," a 50,000 years' supply.

#### PRACTICAL CONSIDERATIONS

As was stated at the beginning of this paper, possible methods for the extraction of the potash from these rocks fall outside of the scope of this study and so will not be discussed here. It may be well, however, to point out very briefly some of the local features that may have a practical bearing.

All the volcanoes lie close to main, and in some cases also to subsidiary, railroad lines now in operation, and all, with the exception of Bolsena, near or not very far, from large cities, either Rome or Naples.

As to power, although Italy is lacking in true coal, yet there is a very considerable amount of water power. Some of this has been utilized in late years in Lombardy and Piedmont, and there must be a noteworthy

supply available in the streams that flow down the west slopes of the Appennines, though, not being a hydraulic engineer, I am not competent to discuss the subject. It may be mentioned that Moderni<sup>3</sup> calls attention to the fact that, at the Bolsena Volcano the Paglia River, which flows around its northern border, can furnish up to 260 hp., while the Marta, that drains the lake at the southeast, would yield up to 753 hp.

Although these volcanoes are surrounded by towns and villages, yet the main slopes of most of them, except the Alban Hills, are for the most part neither well populated nor highly cultivated. This is especially true of the Bolsena, Vico, Bracciano and Rocca Monfina volcanoes. At present there are very numerous, one might well say almost innumerable, lava-flows, varying in dimensions from 2 to 10 or more meters thick and up to 20 or 30 kilometers long, that are readily workable. Indeed, according to Moderni (page 10 of the paper just cited), leucite and leucitic lavas were extracted from the Alban Hills "for industrial purposes" (i. e., not for paving, but presumably for fertilizer uses) to the total amount of 22,300 tons in the years from 1903 to 1909, inclusive. Many quarries have been opened at several of the volcanoes, notably Bolsena, Alban Hills and Vesuvius, for the extraction of paving stones and their refuse, as pointed out by Moderni, would serve as a source of immediate supply of considerable magnitude.

In this connection it may be of interest to note that, according to Moderni, German industrial societies had in recent years, before the war, been active in researches in the Italian leucitic lavas for the manufacture of "chemical products."

#### COMPARISON WITH OTHER REGIONS

Although occurrences of leucitic lavas are scattered rather sporadically over the earth's surface, they are actually very rare rocks, and no other region is as yet known that is so extensive or so rich in them as that of the Italian volcanoes.

The occurrence that first calls for consideration is the very frequently mentioned district of the Leucite Hills, in Wyoming.<sup>4</sup>

A few other localities where leucitic rocks occur in the United States are known, as in Montana, the Yellowstone Park, Arkansas and New Jersey, but these can be of no commercial importance. The lavas of the Leucite Hills are highly potassic, averaging 10 per cent, and in this respect they slightly surpass those of the Italian volcanoes, whose average is nearly 9 per cent. As regards area, volume and amount of potash present, however, they are relatively insignificant. As calculated by Schultz and Cross (p. 35), the total tonnage of the leucitic rocks, including at some of the stocks the rock masses down to a depth of 3000 feet,<sup>5</sup> is 1,973,496,177 short tons, or about 1,794,100,000 metric tons of rock, containing 179,410,000 metric tons of potash. This is about one-fiftieth of the estimate of the potash contained in the Italian lavas, which we have reason to believe to be below the truth. In the one case it is a matter of acres, of area and feet of height, in the other

<sup>2</sup>P. Moderni, *L'Industria Chimica*, etc., I, p. 23, 1914.

<sup>3</sup>For a description of this as a source of potash see Schultz and Cross, *Potash-bearing Rocks of the Leucite Hills*, U. S. Geol. Surv., Bulletin 512, 1912. A full bibliography is given.

<sup>4</sup>Disregarding these, the lavas above the surface amount to about 1,627,819,000 short tons.

<sup>5</sup>See H. S. Gale, U. S. Geol. Surv., Min. Res., 1916, Pt. II, p. 76, 1917.



square kilometers of area and tens of meters of height of lava-flows.

Another silicate source of supply of potash in the United States (though not an igneous rock), is that of the beds of glauconite or greensand marl, of Upper Cretaceous and Eocene age, that extend in a narrow belt from near Sandy Hook, N. J., to beyond, Richmond, Va.<sup>22</sup> Clauconite is essentially a hydrous silicate of iron and potassium. The portions of the deposits that lie in New Jersey are the richest in potash, and a content of 6 per cent in the air-dry material would be a fair estimate for them. In New Jersey the belt is 160 kilometers long, with an average width of 16 kilometers. Assuming an average thickness of 6 meters (about 20 feet) for the glauconite beds, and the above percentage of potash, these New Jersey deposits would contain about 2,034,000,000 metric tons of potash, or about one-quarter or one-fifth of that contained in the Italian volcanoes. It would therefore appear that these glauconite beds of the Eastern States rank next to the Italian volcanoes in total amount of potash. The ease of extraction of the raw material and their proximity to facilities for treatment and transportation would seem to promise them to be of great value.

<sup>22</sup>See Lewis and Kummel, Geol. Sur. of N. J., Bull. 14, p. 135. 1915; G. H. Ashley, U. S. Geol. Sur., Bull. 660-B, p. 27, 1917.

Among other localities where leucitic lavas occur in considerable amount may be mentioned the islands of Java, Celebes and Baween in the East Indies, New South Wales, the Eifel and Baden in Germany, Bohemia, Kamerun and East Africa and the Antarctic. But none of these, with the possible exception of the East Indies lavas, would seem to be sufficiently abundant or with a high enough average potash content to give promise of a commercial source of supply.

#### SUMMARY

Attention is called, as a future possible source of potash, to the leucitic lavas of seven volcanoes along the west coast of Italy, from Bolsena to Vesuvius. The rock types are characterized and the several volcanoes described very succinctly. The volumes of the volcanoes, the tonnage of the lavas, the percentage of potash and the total (minimum) amount of potash at each, are calculated. It is shown that the leucitic lavas of these volcanoes, with an average potash content of about 9 per cent, contain at least 8,786,200,000 metric tons of K<sub>2</sub>O, making them the greatest accumulation of highly potash-rich silicate rocks known. Methods of extraction of the potash are not discussed.

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## The Effect of Addition Agents in Flotation—II

BY M. H. THORNBERRY AND H. T. MANN

AS in the preceding discussion<sup>1</sup> of the effect of addition agents in flotation, the results obtained by the addition of various hydroxides are shown graphically in Charts 4, 5 and 6. The numerals on the charts are the numbers of the various experiments, three being made without any additions and four with each of the different agents. Those without addition agents are numbered 1, 2, 3 and 0, the last showing the average results of the first three. The numbers of experiments with addition agents are given in the following paragraphs, four to each experiment, and indicate results obtained respectively with 5, 15, 25 and 50 cc. of each agent.

To save repetition in the discussion of the results we shall refer in this article to Cleveland Cliffs Iron Company's flotation oil No. 1 as "oil No. 1," and to General Naval Stores flotation oil No. 17 as "oil No. 17."

The reader should also bear in mind that when statements are made that a certain reagent raised or lowered the grade of concentrate or extraction those results are compared with the results obtained when oil was used without any reagent.

#### HYDROXIDES

(NH<sub>4</sub>)OH. Nos. 4 to 7

Ammonium hydroxides, when used with both oil No. 17 and cresylic acid, produced very similar results. The relative extraction was lowered about 7 per cent, while the grade of concentrate produced was only about 3 per

cent low. With oil No. 1 both the extraction and grade of concentrate were lowered about 12 per cent.

NaOH. Nos. 8 to 11

When sodium hydroxide was used the results were so nearly like those of ammonium hydroxide that further discussion is unnecessary.

KOH. Nos. 12 to 15

Potassium hydroxide, when used with oils No. 1 and No. 17, lowered the extraction about 4 per cent, while the grade of concentrate produced was lowered about 6 per cent. Observations and results indicate that there is a possible relation between the flocculating effect of this salt and its effect on flotation results. However, it will take many more determinations to demonstrate the correctness or fallacy of this apparent relation. When this salt was used with cresylic acid the results checked more closely. The average extractions were lowered about 5 per cent, while the average grade of the concentrates was raised 2 per cent.

Ba(OH)<sub>2</sub>. Nos. 16 to 19

With oil No. 1 barium hydroxide lowered the extraction about 15 per cent, and also lowered the grade of concentrate about 10 per cent. With oil No. 17 the extraction was lowered 7 per cent, while the grade of concentrate was lowered 4 per cent. With cresylic acid the extraction and grade of concentrate were lowered 9 per cent.

Ca(OH)<sub>2</sub>. Nos. 20 to 23

Calcium hydroxide, when used with oil No. 1, gave extractions which varied from 2 per cent high to 5 per

<sup>1</sup>This Journal, Dec. 15, 1917, p. 709.

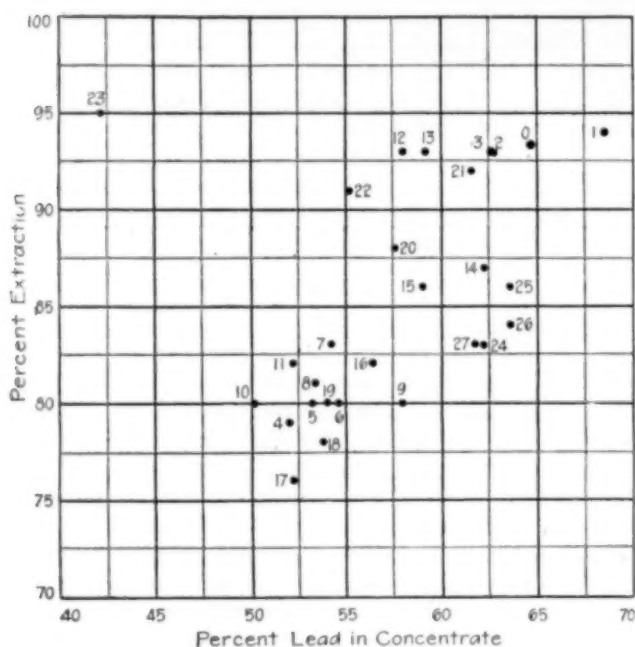


CHART 4—EFFECT OF HYDROXIDES ON FLOTATION OF GALENA WITH OIL NO. 1

cent low, while the lead tenor of the concentrate varied from 2 per cent low to 22 per cent low. With oil No. 17 the extraction varied from 4 per cent low to 10 per cent low, and the grade of concentrate varied from 2 per cent to 22 per cent low. With cresylic acid the extraction varied from 3 per cent high to about 8 per cent low, and the grade of concentrate varied from 2 per cent high to 6 per cent low.

Calcium hydroxide is practically the only hydroxide which exerted a pronounced effect on the character of the froth formed. With oil No. 1, 5 cc. of this salt gave a very wet froth composed of very small bubbles, which formed slowly and broke down very quickly. With 15 cc. the froth was wet, and composed of small

bubbles which broke down slowly. With 25 cc. the froth was dry, and composed of large bubbles which formed quickly. With 50 cc. the froth was very dry, and composed of extremely large bubbles. This froth formed quickly and seemed to carry large quantities of gangue, and broke with difficulty. The froths with oil No. 17 were similar to those formed when oil No. 1 was used. With cresylic acid, 5 cc. of calcium hydroxide gave a wet froth composed of small bubbles which broke very quickly. The froth with 15 cc. was dry. When 25 cc. was used no froth was obtained when the usual quantity of oil—0.5 lb. per ton—was added. To complete the experiment another portion of oil equivalent to 0.250 lb. per ton was added. This extra addition of oil produced a froth composed of large bubbles which broke very quickly. With 50 cc. of this salt it was necessary to double the amount of oil before the tests could be completed. The froth formed when 1 lb. per ton of oil was added was extremely dry and composed of very large bubbles.

The relation between the flocculating effect of this salt and its effect on flotation deserves more work than we can devote to it at the present time.

The character of all froths formed was compared to the froths formed by the oil when no addition agent was present.

#### Mg(OH)<sub>2</sub>, Nos. 24 to 27

Magnesium hydroxide, when used with any one of the three oils, lowered the extraction about 10 per cent, and had very little effect on the grades of concentrates produced. This salt modified the froths formed to such a little extent that no further discussion is necessary.

#### SUMMARY OF EFFECT OF HYDROXIDES

The limited number of hydroxides tested, when considered as a group, produce results which are very similar to the results obtained when sulphates are present. The relative extraction is practically the same, but the grade of concentrates produced is slightly lower than when sulphates are present.

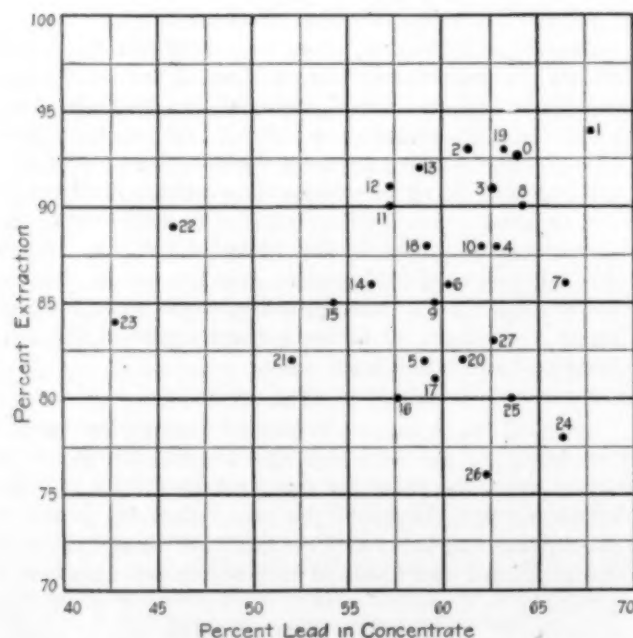


CHART 5—EFFECT OF HYDROXIDES ON FLOTATION OF GALENA WITH OIL NO. 17

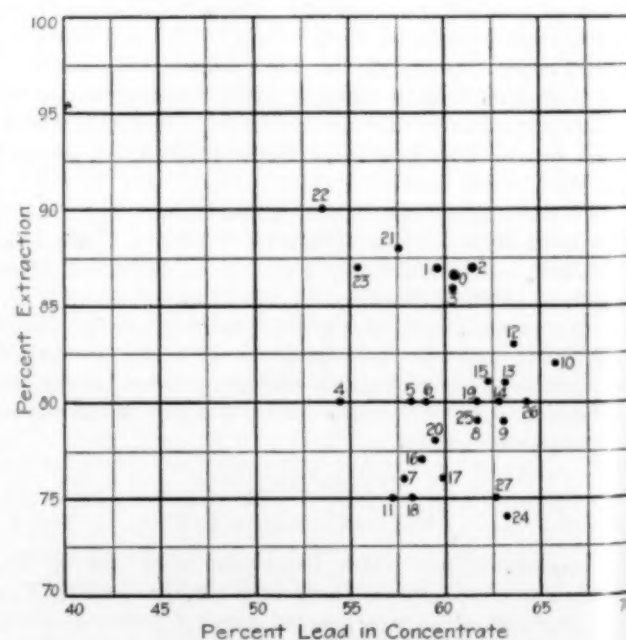


CHART 6—EFFECT OF HYDROXIDES ON FLOTATION OF GALENA WITH CRESYLIC ACID



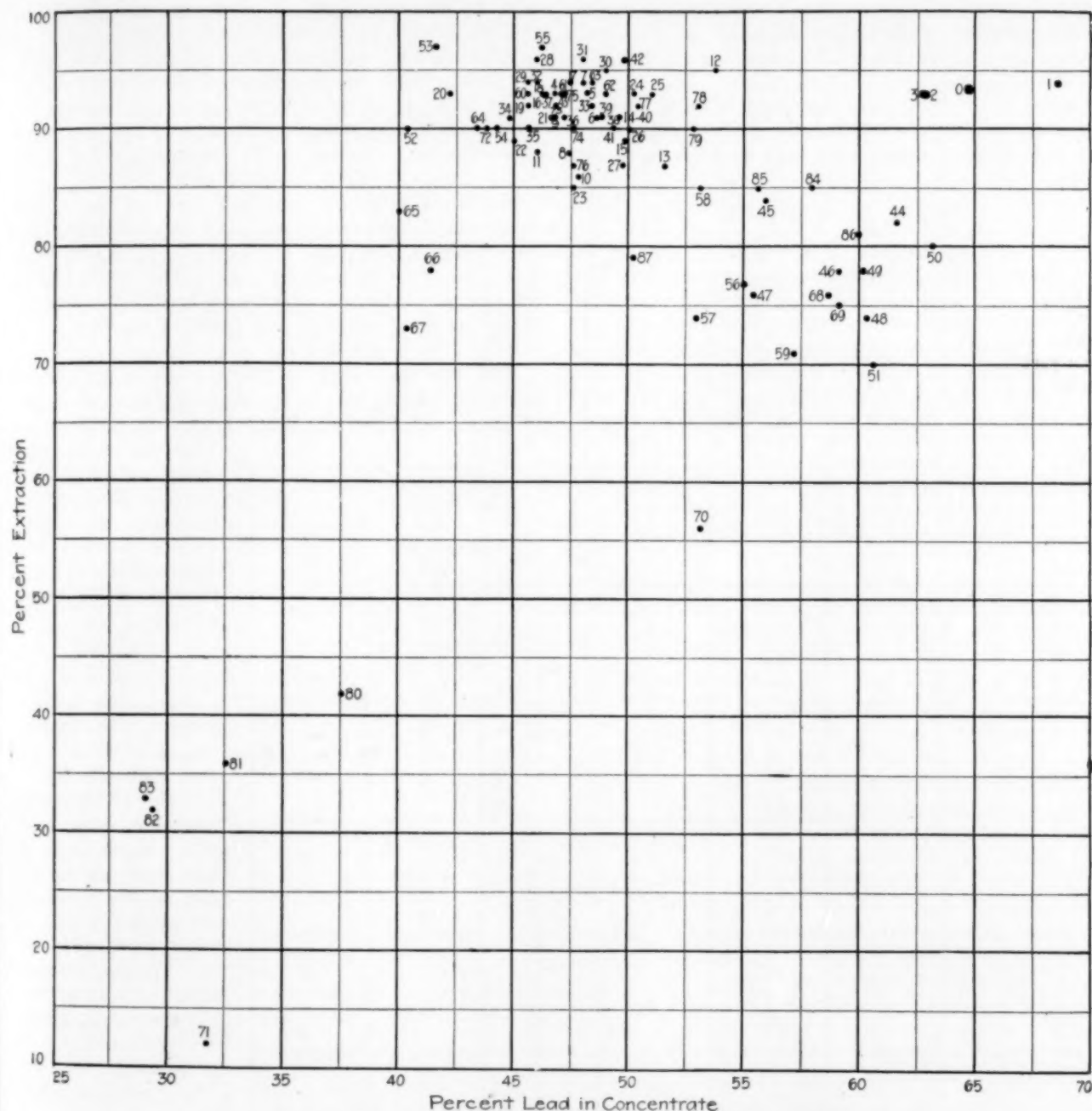


CHART 7—EFFECT OF NITRATES ON FLOTATION OF GALENA WITH OIL NO. 1

## NITRATES

The results of these experiments are set forth in Charts 7, 8 and 9. Attention is here directed to the first three paragraphs of this article for an explanation of the significance of the numbers and their interpretation.

Nitric acid and many of the commoner nitrates when used in flotation tend to produce such an abundance of froth that it was found impractical to add the total amount of oil—0.5 lb. per ton—at the beginning of the test. When the total amount of oil was added at one time the entire amount of froth produced was evolved so quickly that an excessive overflow carrying large quantities of gangue was obtained, thereby necessitating the discarding of the test. To overcome this difficulty, the method of handling the nitrates was modified in the following manner: The desired quantity of the reagent having been added to the charge, oil was

added at intervals in quantities equivalent to 0.125 lb. per ton. After each addition of oil the violent frothing was allowed to subside before another portion of oil was added. This procedure was continued until the total amount of oil—0.5 lb. per ton—had been added and the test was then completed, as described in the method for sulphates.

This tendency of quickly producing a very copious froth was so pronounced with nitric acid that it was found impossible to complete an experiment in which acid had been used. After twelve of fifteen trials with the acid, its use was abandoned.

The character and quantity of froth obtained when the nitrates were used varied widely. Small quantities of one reagent produced a froth composed of large bubbles, while larger quantities of the same reagent produced a froth of small bubbles. This condition was reversed with some of the other reagents. Repeated

tests, however, with the same addition agent under uniform operating conditions maintained in this work, always gave a froth having the same characteristics as mentioned above.

Many of the tests were completed in from 25 to 30 minutes, but were continued the full 40 minutes in order to keep operating conditions as uniform as possible.

#### ALKALI METAL NITRATES

##### $\text{NaNO}_3$ , Nos. 4 to 7.

Sodium nitrate had practically no effect on the extraction when used with oils No. 1 and No. 17, but when used with cresylic acid the extraction is noticeably lowered. The effect on the grade of concentrate produced was just the opposite. The grade of concentrate with oil No. 1 was lowered about 16 per cent; with oil No. 17 it was lowered about 8 per cent, while with cresylic

acid the concentrate was of about the same grade as that produced when no reagent was present.

With oils No. 1 and No. 17 this salt gave a slow forming froth, which was composed of small, wet bubbles, which broke up slowly. With cresylic acid, sodium nitrate gave a dry, ephemeral froth, and the maximum extraction was obtained in 25 minutes.

##### $\text{KNO}_3$ , Nos. 8 to 11.

Potassium nitrate, when used with oil No. 1 and cresylic acid, lowered the extraction more than the corresponding sodium salt. With oil No. 17 it had practically no effect on the extraction. The lead tenor of the concentrate varied with the oil used, being slightly higher with cresylic acid and about 14 per cent lower with oils No. 1 and No. 17.

With oils No. 1 and No. 17 the addition of 5 cc. of potassium nitrate solution produced a froth consisting of large, wet bubbles. When larger quantities were used the froth consisted of small, wet bubbles. With cresylic acid the froth formed slowly and consisted of large, dry bubbles, which broke quickly.

##### $(\text{NH}_4)\text{NO}_3$ ,

##### Nos. 12 to 15.

Ammonium nitrate lowered the extraction slightly when used with oils No. 1 and No. 17, and considerably when used with cresylic acid. It had practically no effect on the grade of concentrate produced when used with oil No. 17, and cresylic acid, but with oil No. 1 it lowered the grade of concentrate about 12 per cent.

This reagent, when used with oils No. 1 and No. 17, gave a very wet froth, composed of small bubbles which broke quickly. With cresylic acid the froth was not so wet, and the concentration was completed in 25 to 30 minutes.

##### $\text{LiNO}_3$ ,

##### Nos. 16 to 19

Lithium nitrate had little or no effect on the extraction. The lead content of the concentrate produced was about 16 per cent lower with oil No. 1,

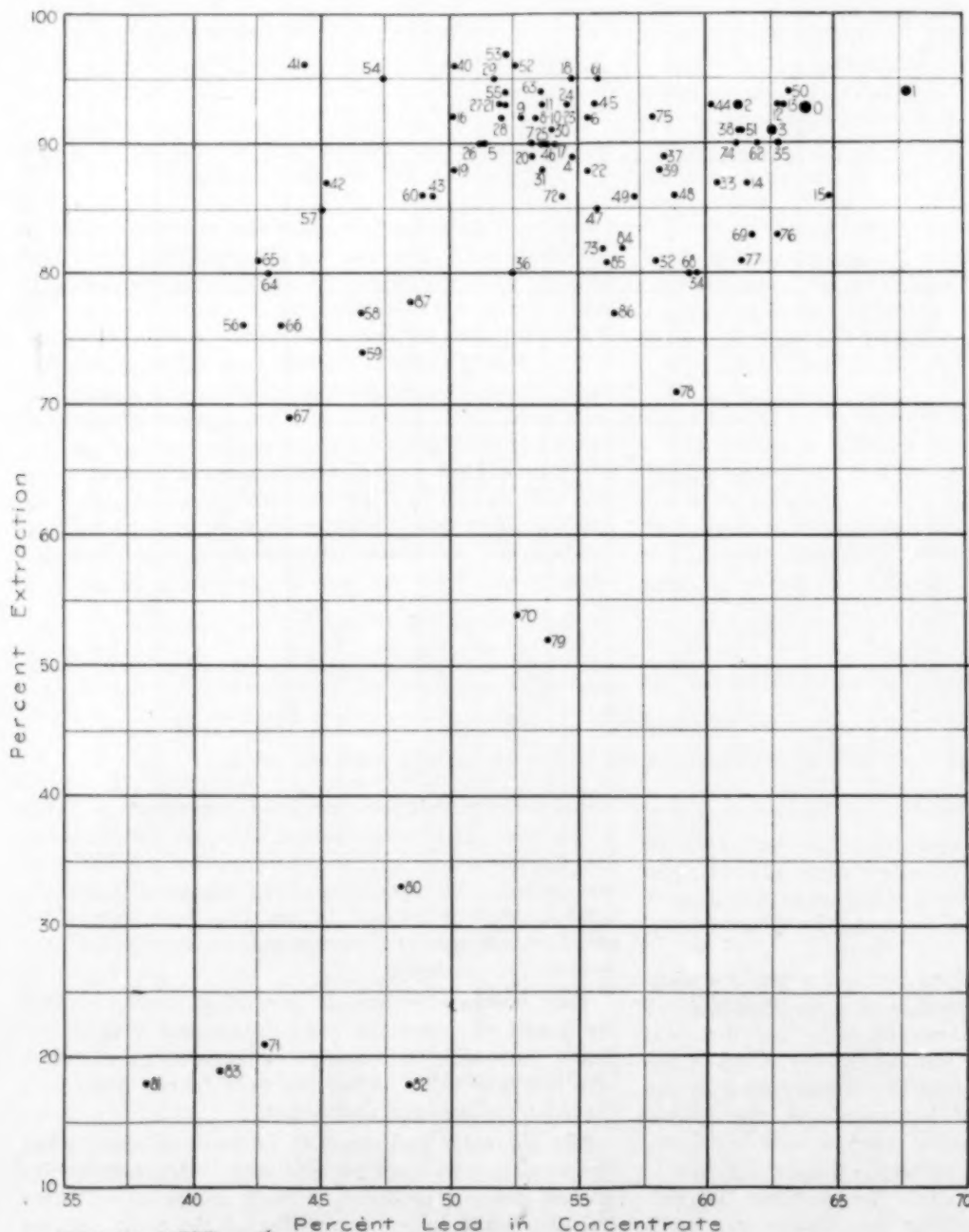


CHART 8—EFFECT OF NITRATES ON FLOTATION OF GALENA WITH OIL NO. 17



12 per cent lower with oil No. 17, and 3 per cent higher with cresylic acid.

The froth formed when this salt was used varied with each oil. Oil No. 1 gave a wet froth, composed of medium-sized bubbles; oil No. 17 gave a froth similar to oil No. 1, except that the bubbles were much smaller. Cresylic acid gave a dry, ephemeral froth, composed of medium-sized bubbles, and the concentration was completed in about 25 minutes.

The alkali metal nitrates tested gave very similar results, the general tendency being to lower slightly the extraction. The effect on the grade of concentrate produced seemed to depend more on the oil used than on any particular nitrate of this class, or on the quantity of the nitrate used.

When used with oils No. 1 and No. 17, which produce a high-grade concentrate without any reagent, the alkali metal nitrates lowered the grade of concentrate very noticeably, but when used with cresylic acid, which has a tendency toward making a low-grade product, these nitrates have practically no effect on the concentrate produced.

#### ALKALINE EARTH NITRATES

##### $\text{Ba}(\text{NO}_3)_2$ , Nos. 20 to 23

Barium nitrate lowered the extraction about 4 per cent, regardless of the oil used. The effect of the grade of concentrate produced varied with the oil. Oil No. 1

lowered the lead tenor of the concentrate 18 per cent; oil No. 17 lowered the grade of the concentrate about 10 per cent; while with cresylic acid the concentrate was of practically the same grade as the one produced when no reagent was used.

The froths formed varied widely with this salt. With small quantities of barium nitrate, oil No. 1 gave a wet froth composed of medium-sized bubbles, which broke slowly, while larger quantities of this reagent gave a dry froth composed of large bubbles. With oil No. 17 the froth was very wet and had a long life. Cresylic acid produced a wet ephemeral froth, consisting of large bubbles, and the concentration was completed in 30 min.

##### $\text{Ca}(\text{NO}_3)_2 \cdot 4\text{H}_2\text{O}$ , Nos. 24 to 27

Calcium nitrate, when used with oils No. 1 and No. 17, had practically no effect on the extraction; but when used with cresylic acid the extraction was lowered about 7 per cent. The effect of this salt, when used with cresylic acid, on the grade of concentrate produced is practically nil, but when used with oils No. 1 and No. 17 the concentrate is lowered about 12 per cent.

The froths formed when using this reagent with oils No. 1 and No. 17 was composed of small, wet bubbles, which broke readily. With cresylic acid the froth varied from small, wet bubbles when small quantities of the reagent were used, to a dry, stiff froth with the larger quantities.

##### $\text{Sr}(\text{NO}_3)_2 \cdot 4\text{H}_2\text{O}$ ,

##### Nos. 28 to 31

The effect of strontium nitrate on both the extractions and grade of concentrates produced was very similar to those of calcium nitrate, regardless of the oils used. The froths which formed were likewise very similar to those of the corresponding calcium salt, with the exception that they contained more water.

##### $\text{Mg}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$ ,

##### Nos. 32 to 35

Magnesium nitrate is very similar in all its effects to the corresponding calcium salt.

When the alkaline earth nitrates are considered as a group, the results obtained correspond so closely with those obtained with the alkali metal nitrates that further discussion is unnecessary.

#### METALLIC NITRATES

##### $\text{Mn}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$ ,

##### Nos. 36 to 39

Manganese nitrate lowered the extraction about 3 per cent, regardless of the oil used. The grade of concentrate was lowered about 16 per cent with oil No. 1, and about 4 per cent with oil No. 17, but with cresylic acid the concentrate was raised about 3 per cent.

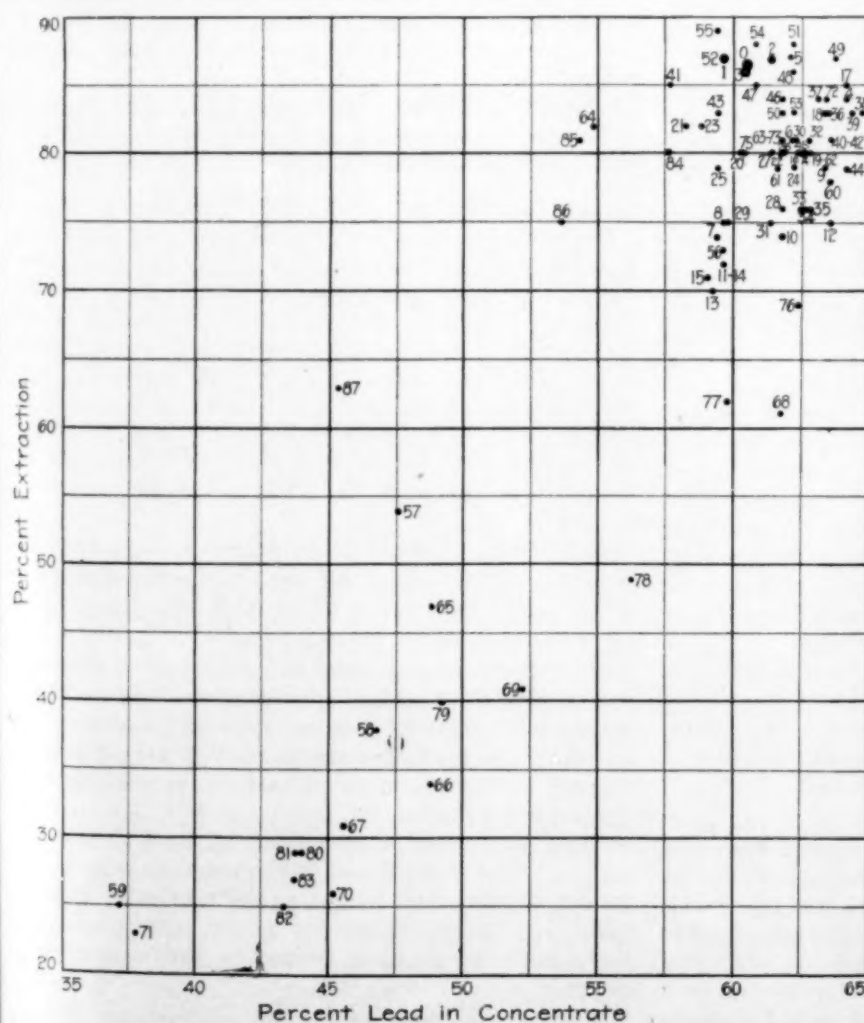


CHART 9—EFFECT OF NITRATES ON FLOTATION OF GALENA WITH CRESYLIC ACID

The froth formed varied with the oil used. Oil No. 1 gave a wet froth, consisting of small bubbles; oil No. 17 gave a wet, ephemeral froth made up of medium-sized bubbles, and cresylic acid gave a dry, ephemeral froth composed of large bubbles.

$\text{Ni}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$ . Nos. 40 to 43

Nickel nitrate had practically no effect on the extraction when used with any one of the three oils. The grade of concentrate varied with the oil. When oil No. 1 was used the concentrate was lowered about 16 per cent. With oil No. 17 the concentrate was lowered about 14 per cent. The concentrate formed when cresylic acid was used was of about the same grade as that obtained when no reagent was present.

Oils No. 1 and No. 17, when used with 5 cc. of this salt, produced an ephemeral froth composed of very small bubbles. When larger quantities of the reagent were added, these oils produced a froth composed of very large bubbles, which had an exceptionally long life. Cresylic acid gave a dry, ephemeral froth composed of large bubbles.

$\text{Co}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$ . Nos. 44 to 47

With cobalt nitrate and oil No. 1 the extraction was lowered about 13 per cent. The effect of this salt is so nearly like the effect of nickel nitrate in all other respects that further discussion is unnecessary.

$\text{Fe}(\text{NO}_3)_3 \cdot 9\text{H}_2\text{O}$ . Nos. 48 to 51

The extractions obtained when ferrous nitrate was used varied more with the oil than with the quantity of the reagent added. With this salt and oil No. 1 the extraction was lowered about 17 per cent; when oil No. 17 was used the extraction was lowered only 4 per cent, while with cresylic acid the extraction is practically the same as when no reagent was present. The effect on the grade of concentrate produced was very slight. With oils No. 1 and No. 17 the concentrate was lowered about 3 per cent; with cresylic acid it was raised about 2 per cent.

The froths formed were very similar to those formed when nickel nitrate was used.

$\text{Cu}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$ . Nos. 52 to 55

Copper nitrate had practically no effect on the extraction when used with any one of the three oils. The effect on the grade of concentrate produced varied with the oil used. Oil No. 1 produced a concentrate which contained 22 per cent less lead than that obtained without a reagent. Oil No. 17 gave a 13 per cent lower grade concentrate, while cresylic acid gave a concentrate having practically the same composition as that obtained when no reagent was present.

The froth formed when copper nitrate was used with oil No. 1 consisted of very small, wet bubbles. Oil No. 17, when used with this salt, produced a froth composed of wet medium-sized bubbles, while cresylic acid produced a froth of very large, dry bubbles.

$\text{AgNO}_3$ . Nos. 56 to 59

The results obtained when silver nitrate was used varied greatly. With oils No. 1 and No. 17, some of the extractions were lower than others, but this variation did not occur uniformly as the amount of silver nitrate solution was increased. With oil No. 1 the extractions varied from 10 per cent to 25 per cent low, while with oil No. 17 they varied from 8 per cent to 19 per cent low. The lead tenor of the concentrates

with oil No. 1 was lowered about 10 per cent, while with oil No. 17 the grade of concentrate varied from 16 per cent to 20 per cent low.

When cresylic acid was used, both the extraction and grade of concentrate were lowered in accordance with the amount of silver nitrate present. When 5 cc. of the salt was present the extraction was lowered 14 per cent, while the lead tenor of the concentrate was lowered only 1 per cent. But when 50 cc. of the reagent was added the extraction was lowered 62 per cent, and the lead tenor of the concentrate 23 per cent. These results, when plotted, show a fair curve in which the extraction and grade of concentrate fall as the amount of silver nitrate is increased.

The character of the froths formed when silver nitrate was used varied widely. With oil No. 1 small amounts of this salt produced an extremely wet froth, but when the maximum amount of the salt was added the froth was exceedingly dry and very stiff. With oil No. 17 the froths were not as extreme as were those with the preceding oil. Cresylic acid produced dry, ephemeral froths composed of large bubbles which seemed to have very little carrying power.

$\text{Pb}(\text{NO}_3)_2$ . Nos. 60 to 63

Lead nitrate, when used with oils No. 1 and No. 17, had no effect on the extraction, but when used with cresylic acid the extraction was lowered about 7 per cent. The concentrate produced follows the usual order, being about 17 per cent low with oils No. 1 and No. 17, and 2 per cent or 3 per cent high with cresylic acid.

The froths formed when this salt was used likewise follow the usual order; small, wet bubbles with oil No. 1 to large, dry bubbles with cresylic acid.

$\text{Hg}(\text{NO}_3)_2 \cdot \text{H}_2\text{O}$ . Nos. 64 to 67

Generally speaking, mercuric nitrate had a detrimental effect both on the extraction and the grade of concentrate produced, regardless of the oil used. When used with oil No. 1, the extraction was lowered about 10 per cent, and the grade of concentrate about 22 per cent. When used with oil No. 17, the extraction was lowered about 18 per cent, and the grade of concentrate 20 per cent. When used with cresylic acid the effect on both the extraction and grade of concentrate is almost identical with the effect produced by silver nitrate.

The froths produced by mercuric nitrate were all wet, and varied only in the amount of water they contained.

$\text{UO}_2(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$ . Nos. 68 to 71

Uranyl nitrate is another reagent which has a very detrimental effect on both the extraction and grade of concentrate produced. Its effect is very similar with all three oils, in that as the amount of uranyl nitrate solution was increased the extraction and the grade of concentrate were lowered.

There also seemed to be a relation between the character of froth formed and the extraction, in that the more water the froth contained the poorer the extraction. The froths formed very slowly, were very light, broke down quickly, and seemed to have no carrying power.

$\text{Al}(\text{NO}_3)_3 \cdot 9\text{H}_2\text{O}$ . Nos. 72 to 75

The effect of aluminium nitrate is practically the



same as with manganese nitrate, hence no further discussion is necessary.

$\text{Bi}(\text{NO}_3)_3 \cdot 5\text{H}_2\text{O}$ . Nos. 76 to 79

Bismuth nitrate, when used with oil No. 1, lowered the extraction about 5 per cent and the grade of concentrate about 15 per cent. When used with oil No. 17 and cresylic acid, both the extractions and the grade of concentrates were lowered as the amount of the salt was increased.

All the froths formed consisted of small, wet bubbles.

$\text{Cd}(\text{NO}_3)_2 \cdot 4\text{H}_2\text{O}$ . Nos. 80 to 83

Cadmium nitrate, like cadmium sulphate, had a very pronounced effect on the extraction and grade of concentrate, in that both were lowered enormously. When cadmium sulphate was used there seemed to be a marked relation between the amount of the salt present and the results obtained, but when cadmium nitrate was used this relation was not brought out so forcibly.

The froths formed with oil No. 1 and this nitrate were very wet, while with cresylic acid they were dry.

$\text{Zn}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$ . Nos. 84 to 87

Zinc nitrate lowered the average extraction about 12 per cent, and the grade of concentrate averaged about 8 per cent to 9 per cent low.

The froths formed varied from small, wet bubbles to large, dry bubbles, depending on the quantity of reagent added and the oil used.

#### SUMMARY OF EFFECT OF NITRATES

The nitrates used, when considered as a whole, gave widely divergent results, which seemed to depend more on the oil than on any other factor.

When oil No. 1 was used the average extraction, with a few exceptions, was practically the same as when the oil was used without any reagent, but the average grade of concentrate produced was lowered about 17 per cent.

When oil No. 17 was used, the average extraction was lowered slightly, while the grade of concentrate was lowered from 8 per cent to 10 per cent.

With cresylic acid, the average extraction was lowered about 7 per cent, but the grade of concentrate produced was raised 2 per cent or 3 per cent.

The nitrates had a very striking effect on the character of the froth formed. When used with oil No. 1, the froth was usually composed of small, wet bubbles. In a few cases the bubbles were so small that the froth resembled a thick scum.

When oil No. 17 was used, the bubbles were larger and the froth was not so wet as that produced with oil No. 1.

When cresylic acid was used, the froth was usually dry, and composed of large bubbles, which seemed to have very little carrying power.

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## Work of the British Nitrogen Products Committee

Plans Under Way for Cyanamide, Ammonia, Oxidation, and Experimental Synthetic Ammonia Plants

ENGLAND has attacked the nitrogen problem much the same as the United States. A Nitrogen Products Committee was formed in June, 1916, following the formation of the Munitions Inventions Department. The Ministry of Munitions has recently issued a memorandum on the nitrogen problem and the work of the Nitrogen Products Committee, which we herewith reproduce from the Journal of the Society of Chemical Industry.

#### THE NITROGEN PROBLEM

The manufacture of the vast quantities of explosives that have been called for by the present conditions of warfare has led to an unprecedented demand for various nitrogen compounds. The world's consumption of nitrogenous fertilizers appears practically to double every ten years, and in 1913 had attained the large figure of 2,500,000 tons of Chile nitrate and about 1,400,000 tons of ammonium sulphate.

With the outbreak of the war the demand for explosives became of paramount importance and the requirements of agriculture for the time being took a secondary position. The prospect of world shortage of food, however, has served to bring the agricultural aspect of the problem again into the forefront. The researches of Sir William Crookes and of Lord Rayleigh upon the fixation of atmospheric nitrogen by means of the electric arc pointed the way to a method of utilizing the unlimited supply of nitrogen in the air.

The establishment on a very large scale during the past 20 years of processes for nitrogen fixation is one of the most striking electrochemical developments of modern times. Special reference may be made to the arc process, as used in Norway, the Haber or synthetic ammonia process developed in Germany, and to the cyanamide process for the manufacture of nitrolim from calcium carbide, as carried on in Norway, Sweden, France, Italy, Germany and the United States.

In spite of the fact that the incentive to the commercial establishment of nitrogen fixation may be said to have originated in this country, no steps were taken in the United Kingdom to obtain nitrogen compounds other than cyanides synthetically. The ammonia recovered at gas works and coke ovens has constituted practically the only form of combined nitrogen produced in this country. During the war the command of the seas has hitherto enabled Great Britain to rely entirely upon importation for the whole of our supplies of nitrate of soda, the most important raw material of our explosives industry. The Central Powers, on the contrary, having been cut off from external supplies, were compelled to fall back upon their internal resources, with the result that nitrogen fixation processes, some of which were established commercially before the war, have been developed upon an enormous scale.

Soon after the formation of the Munitions Inventions Department in August, 1915, proposals for the fixation of nitrogen began to be received from inventors. These schemes were referred to the Chemical Inventions Com-

mittee of the Advisory Panel, but as they were isolated applications of the general problem and were of limited scope they did not immediately lead to any definite line of policy being taken upon the question. The importance of the problem was recognized, however, and the attention of the Minister was directed to it from time to time in the monthly departmental reports.

The inauguration of the submarine campaign in February, 1916, and the grave menace to overseas supplies of nitrates emphasized the importance of taking action on the matter. At this opportune moment a memorandum on the nitrogen problem was submitted to the Department by the Faraday Society. Several conferences were held to discuss the steps that should be taken, and, as a result, the Nitrogen Products Committee was constituted in the following June. Members of the Advisory Panel, representatives of other Departments of the Ministry of Munitions and of the Government, and delegates of the leading scientific societies were invited to serve. The terms of reference were:

- (1) To consider the relative advantages for this country and for the empire of the various methods for the fixation of atmospheric nitrogen from the point of view both of war and peace purposes; to ascertain their relative costs, and to advise on proposals relevant thereto which may be submitted to the department.

- (2) To examine into the supply of the raw materials required, *e.g.*, pure nitrogen and hydrogen, and into the utilization of the by-products obtained.

- (3) Since some of the processes employed depend for their success on the provision of large supplies of cheap power to ascertain where and how this can best be obtained.

- (4) To consider what steps can with advantage be taken to conserve and increase the national resources in nitrogen-bearing compounds and to limit their wastage.

- (5) To carry out the experimental work necessary to arrive at definite conclusions as to the practicability and efficiency of such processes as may appear to the committee to be of value.

- (6) As a result of the foregoing steps to advise as to starting operations on an industrial scale.

An important advance was made when the then Minister of Munitions, the Right Hon. E. S. Montagu, M. P., met the members of the committee on October 10, 1916. He assured them that the Government appreciated the importance of the nitrogen problem, and that he would do everything in his power to see that the recommendations ultimately made received the fullest consideration. At this meeting Sir William Crookes was able to be present. At the same meeting the organization of the committee was completed, and the following sub-committees were set up: Processes, Economics, Experiments, Power and General Purposes.

At a later date another sub-committee was found necessary to deal with the question of coal distillation processes and the production and utilization of power gas. The Gas Firing Sub-Committee was accordingly constituted. In all the committee and its sub-committees have held upwards of eighty meetings.

The necessity for research was evident from the outset, and the department at once took steps for the organization of a suitable research staff and the acquisition of a laboratory. Fortunately, the co-operation of the

authorities of University College was secured, and a part of the new Ramsay Laboratory, at that time scarcely completed, was placed at the disposal of the department.

#### NITROGEN FIXATION RESEARCH

The item placed first on the research programme was a complete investigation into the production of synthetic ammonia by the Haber process. The decision was influenced by the claims made for the process and by the commanding position it occupies in Germany, where the economic conditions as regards coal supplies and the comparative absence of water power are similar to those in Great Britain. Moreover, the almost complete lack of precise information concerning the commercial details of this process made it apparent that the research would present many unknown factors, and was therefore likely to occupy a considerable time.

Towards the end of the year the committee came to the conclusion that the ammonia oxidation process was well adapted as an emergency measure for securing quickly a considerable output of nitric acid or nitrates. Although already working with more or less success upon the Continent the process had not at that time been operated in this country. A systematic investigation of the most recent developments of the process was therefore undertaken.

Many important problems have arisen in connection with the two main researches indicated above. Reference may be made to such questions as the most efficient and commercially practicable catalysts for the synthesis of ammonia and for ammonia oxidation, and the commercial preparation in bulk and at a sufficiently low cost of hydrogen of the high degree of purity required for the synthesis of ammonia.

On account of the formidable technical difficulties presented by the different problems it was obvious that a research staff of considerable experience in all the recent developments of physical chemistry was needed for carrying quickly to a successful issue the work of the research program. In the selection of the personnel, therefore, endeavor was made to obtain men possessed of special qualifications. The department has been fortunate in securing a number of such men, with the result that the progress made has been more rapid than might have been expected under the present difficult circumstances. It may be mentioned that the chemist responsible for the research on the synthesis of ammonia had the advantage of having previously worked for some time on the problem at Professor Haber's laboratory at Karlsruhe.

In December, 1916, when the research work was in its early stages, a demonstration and lecture took place at the Research Laboratory and was attended by representatives of the Explosives Supply Department and of the War Office, and by delegates and members of other Government departments and of scientific societies. The Minister of Munitions was unable to be present, but early in 1917 he asked for practical recommendations to be submitted to him at any early date.

In view of the magnitude and complexity of the problem the committee was unable immediately to present a complete report. Certain definite conclusions had been arrived at, however, and these, together with recommendations thereon, were embodied in a unanimous



interim report which was submitted to the Minister of Munitions in February, 1917. The substance of the recommendations is given below:

#### INTERIM REPORT OF THE COMMITTEE

(a) *By-product Ammonia*.—The importance of increasing the output of by-product ammonia for munitions and for agriculture was pointed out. Steps were indicated whereby an increase could be obtained from existing gas works and coke oven plants. It was also recommended that action should be taken to avoid the loss of ammonia known to be occurring in certain districts.

(b) *Ammonia Oxidation Process*.—The erection at the earliest possible moment of plant capable of producing in the aggregate at least 10,000 tons of nitric acid per annum from gas works or coke oven ammonia was recommended.

(c) *Cyanamide Process*.—The erection of a factory having an annual output of the order of 50,000 tons of cyanamide was recommended, the cyanamide to be utilized as such for agriculture or for the production of ammonia.

(d) *Synthetic Ammonia Process*.—The erection of a full-sized trial unit plant for synthetic ammonia process was recommended.

The Minister of Munitions invited members of the committee to meet him, and the recommendations of the interim report were discussed in detail. At the conclusion of this meeting the Minister appointed a small Executive Committee to supervise the action involved in giving effect to his decisions, and to report to him from time to time upon the progress made.

#### THE MINISTER'S DECISIONS AND THE ACTION TAKEN THEREON

The Minister's decisions were as follows:

(a) *By-product Ammonia*.—The committee was requested to deal with the problem of conserving ammonia and of augmenting the output on the lines of the recommendations.

(b) *Ammonia Oxidation Process*.—The Ministry of Munitions would undertake the installation of one Government plant on the lines suggested, or if the committee so advised the Ministry would agree to the erection of plants by suitable private firms. The information resulting from the research work was to be placed freely at the disposal of *bona fide* manufacturers, but was not to become the exclusive property of any firm or group of firms.

(c) *Cyanamide Process*.—The committee was requested to investigate the relative merits of a Government scheme and of other schemes that had been put forward involving private enterprise and to submit a report embodying definite proposals.

(d) *Synthetic Ammonia Process*.—The erection of the full sized trial unit was authorized.

In carrying out these decisions the Executive Committee dealt first with the problem of conserving and increasing the output of by-product ammonia. The co-operation of the Controller of Coal Mines, of the gas companies and of the domestic and industrial users of coke was enlisted, and the matter was then placed under the direction of the Explosives Department in March, 1917, in view of its existing organization for dealing with the supply of ammonia.

The next step taken was to summon a conference of manufacturers likely to be interested in the ammonia oxidation process, as a good deal of information had been collected regarding it and the research work had already reached a semi-commercial stage. Conferences took place at the Munitions Inventions Department in March, 1917, and were attended by representatives of a number of the more important interests. Several manufacturers at once agreed to take up the further study of the process with a view to its commercial development, and have since actively co-operated with the department. Some of them have already erected experimental plant on a considerable scale.

Encouraging progress continued to be made with the research, and arrangements and plans were made for the erection in London of a trial plant consisting of a single commercial unit designed to give an output of one ton of strong nitric acid per day. At this stage the work of establishing the process on a commercial scale for the manufacture of nitric acid and ammonium nitrate was handed over to the Explosives Department at their request in August, 1917. The work of investigation, however, has been continued at the Research Laboratory, as several important aspects of the process still remain to be explored.

With regard to the manufacture of cyanamide the Executive Committee came to the conclusion that the schemes involving private enterprise did not adequately fulfill the ends in view and recommended the erection of a factory by the Government. The committee proceeded to collect further information on cyanamide processes in actual operation and representatives proceeded overseas for this purpose. Complete details of a scheme involving a large scale factory with electric power station are now in course of preparation for submission to the Minister of Munitions.

Meanwhile a considerable amount of work had been carried out in connection with the synthesis of ammonia, including a detailed investigation of the whole of the conditions governing the process and of the efficiency and life of numerous catalysts. These studies led to the devising of a method of working whereby the output of ammonia per unit of catalyst space has been increased to a figure, which, as far as is known, exceeds anything hitherto attained. The design and erection of a semi-technical unit apparatus embodying a number of novel features, with the necessary pumps, circulators, gas holders, etc., was then undertaken. It is expected that the operation of the unit, which is now at work, will enable the remaining problems as to the chemical engineering details involved in the design of the full sized trial unit authorized by the Minister to be definitely settled.

Research upon the preparation of pure hydrogen in bulk has been carried on conjointly with the above investigations and arrangements have already been made for the trial on a semi-commercial scale of a process that has given very promising results in the laboratory.

#### NITROGEN IN SULPHURIC ACID MANUFACTURE

An important practical outcome of the conferences with manufacturers has been the introduction of ammonia oxidation plant to take the place of the nitre pots used in the manufacture of sulphuric acid by the lead chamber process. In pre-war times the annual con-

sumption of Chile nitrate for this purpose amounted to 18,000 tons. With the present increased output of sulphuric acid the consumption is greater, so that the possible saving of overseas freight is appreciable.

One of the small converters designed in and made for the Department Research Laboratory has been installed at the sulphuric acid works of Messrs. Brunner, Mond & Co. and has been working satisfactorily for some months. The firm is now arranging to adapt similar converters to the whole of their lead chambers. The United Alkali Co., the South Metropolitan Gas Co. and others are making arrangements to adopt the process and are utilizing two types of converter to the laboratory designs. Drawings have also been placed at the disposal of the Explosives Department for the benefit of other controlled establishments.

The apparatus is compact; the expense involved in its installation, apart from ammonia purification plant, is comparatively small, and its operation is simple. Arrangements have therefore been made for the rapid manufacture of the converters likely to be required, since it is believed that these designs may become standard types for the purpose in question. An explanatory pamphlet, compiled by the research staff and embodying detailed information concerning the construction and operation of the converters, will be available shortly for the use of firms who have already taken up the process or are desirous of doing so.

#### FURTHER RESEARCH

Up to the present date the research has practically been confined to the two processes mentioned above and to problems arising therefrom. The investigations of the committee have shown, however, that many important and promising fields still remain to be explored.

Under present circumstances all activities have been concentrated upon processes which have a possible value as war measures and no attempt has been made to extend the programme of research beyond such limits. In view, however, of the national importance of the nitrogen problem, both now and in the future, it is hoped that definite arrangements will be made to preserve the continuity of the research after the war.

#### THE IMPORTANCE OF CHEAP ELECTRIC POWER

It was recalled from the outset that the generation of electric power at a cost decidedly lower than has hitherto been attained in this country was a vital factor if an attempt was to be made to establish certain of the nitrogen fixation industries in Great Britain on a sound economic basis from the point of view of post-war competition. A thorough inquiry has therefore been made as to the possibility of cheapening the production of electric power from coal, not only by its generation in bulk with the most modern plant, but also by the use of methods involving carbonization and gasification, with recovery of the ammonia, fuel oils and other by-products hitherto wasted when raw coal has been directly used. The sub-committees concerned have had the advantage of obtaining the personal views of a number of experts who attended to give evidence on different aspects of the problem. This inquiry has been distinctly fruitful, and much detailed information has been collected.

Schemes for the utilization of various undeveloped water powers in the British Islands for nitrogen fixation

have also been submitted and have been carefully examined. At least one of these schemes for hydro-electric development on a considerable scale presents *prima facie* prospects of becoming a valuable national asset. The Power Sub-Committee recommended that a survey should be made of the drainage area in question with a view to confirming the details of the scheme as submitted. The survey has recently been completed and is expected to result in the formulation of a definite development scheme for the utilization of this water power. It is estimated that the engineering work involved will take about two years to complete, and the scheme is therefore to be regarded as a post-war measure.

#### COSTS OF OPERATING NITROGEN FIXATION PROCESSES

Since many of the nitrogen fixation processes have not only a value for munitions but also a post-war importance, endeavors have been made to investigate the probable requirements of this country for nitrogen requirements of this country for nitrogen products. A detailed examination has been made of the production, consumption, imports and exports of such products, and special consideration has been given to the question as to the relative order of the costs involved in operating the synthetic and non-synthetic processes.

Most of the information relating to synthetic processes has had to be obtained from foreign sources, and the committee has been able to secure many figures of an authoritative character. The information thus collected has been subjected to critical examination in the light of manufacturing experience in allied industries and conclusions have been arrived at as to the costs likely to be incurred under British conditions.

The magnitude of this part of the inquiry may be measured when it is stated that the committee is in possession of comprehensive data concerning the cost of manufacture of:

- (a) Nitric acid and nitrates by the older methods, and by the arc and ammonia oxidation processes.
- (b) Calcium carbide and cyanamide.
- (c) Ammonia and ammonium sulphate by the Haber and cyanamide processes.
- (d) Hydrogen and nitrogen.

As well as concerning the costs involved in operating the Chili nitrate and the by-product ammonia industries.

#### CO-OPERATION WITH OTHER GOVERNMENT DEPARTMENTS

Realizing that many of the branches of the committee's activities related to problems which were also occupying the attention of other Government departments, an attempt has been made to secure as far as possible co-operation and interchange of information. Thus on the question of the carbonization of coal, an exchange of views has taken place with the Fuel Research Board. On the question of the production of hydrogen on a large scale at the lowest possible cost a problem of great importance in connection with aeronautics, collaboration in experimental work with the Admiralty has been arranged. It will be noted that the constitution of the committee has provided for liaison with the Explosives Department, the Board of Agriculture, the Board of Trade and a number of scientific societies.

In accordance with the terms of reference the final report of the Nitrogen Products Committee will include



a review of the nitrogen problem as it affects the British Empire. This branch of the work has not yet been fully dealt with, but representations have been made to the Dominions, to dependencies (through the Colonial Office), to Egypt and to India informing the governments concerned of the activities of the committee and offering to place at their disposal all the information in the possession of the department.

As a result of the negotiations thus instituted the department is already in direct touch with official representatives of the Governments of Australia, Canada, New Zealand, South Africa, Africa, Egypt and Mysore, and also with important developments in other parts of India.

#### NITROGEN FIXATION IN ALLIED COUNTRIES

An interesting event was the visit to this country in February, 1917, of a delegation from the recently constituted Commission de l'Azote acting under the French Ministry of Munitions. It was soon evident that the delegation was most immediately interested in the various processes already established in this country for the manufacture of ammonium nitrate, and a visit of inspection to many of the controlled establishments was accordingly arranged through the Explosives Department.

Several conferences with the delegates were held at the M.I.D. during their stay in this country, and an interchange of ideas and information took place upon the most recent developments in nitrogen fixation in France and Switzerland. The entente thus established has been maintained by the periodical exchange of information and documents between the French Ministry of Inventions and the Munitions Inventions Department.

The Allied Governments of Italy and Russia have also nominated representatives to act in liaison with the department upon the nitrogen problem. The developments already accomplished in the countries in question have enabled these liaison officers to afford immediate and valuable assistance.

The action taken by the United States Government on the nitrogen question is also worthy of notice. Under the National Defence Act of 1916 a sum of \$4,000,000 was set aside for the establishment in the United States of nitrogen fixation on a large scale. Committees of the Academy of Sciences and afterwards of the Ordnance Department were set up. Their advisers visited England, and the more important nitrogen-fixation installations on the Continent outside Germany. Upon the recommendation of their experts the U. S. A. War Department has decided to erect forthwith works for the manufacture of synthetic ammonia by a modified Haber process.<sup>1</sup>

#### FINAL REPORT OF THE NITROGEN PRODUCTS COMMITTEE

The various sub-committees set up by the Nitrogen Products Committee have already completed or are now engaged upon their final reports. There will then remain the report of the main committee, which will of necessity be a somewhat detailed document owing to the scope of the inquiry that has been undertaken. Endeavors are being made to expedite the last stages of the work so that the final report may be available at the earliest possible date.

<sup>1</sup>Editor's Note: The War Department is also building a large cyanamide plant at Muscle Shoals. See our issue of Jan. 1, 1918, p. 1.

## Current News and Notes

**New Jersey Industries on War Basis.**—New Jersey is the first state in the United States to undertake the organization of its manufacturing industries on a war basis, with the object of assisting the Government, and this step was taken Dec. 19 at the War Convention of the Manufacturers' Council of the New Jersey State Chamber of Commerce, held at the Robert Treat Hotel, Newark. The iron and steel industry was represented by L. S. Ayre, International Motor Co., Plainfield, N. J., and Arthur E. Barlow, Barlow Foundry Co., Newark.

**Composition of Canadium.**—Canadium is a composition alloy composed of 70 parts tungsten and 30 parts chromium, annealed. Trade name Canadium, sold by The Franklin Chemical Co., Ltd., London, England.

**Chemists' Club for France.**—An organization has been effected in France to be known as the Cercle de la Chimie, and will maintain headquarters at 54 rue de Turbigo, Paris. The *Revue des Produits Chimiques* will be the official organ of the Cercle de la Chimie. The club building will contain a reading room, a writing room, a lounge room and all the conveniences and comforts of a modern club. Provision is made for the holding of scientific meetings, and extensive literature will be available. Chemists and chemical engineers who go to France will welcome the opportunity to visit this club.

**Colorado Scientific Society.**—At the thirty-fifth annual meeting of the Colorado Scientific Society the following officers were elected to serve during 1918: President, Dr. Richard B. Moore; first vice-president, Mr. Lewis B. Skinner; second vice-president, Mr. Marmaduke B. Holt; treasurer, Mr. John W. Richards; secretary, Mr. Harry J. Wolf; executive committee: term expires Jan. 1, 1921, Mr. J. Claire Evans and Mr. M. S. MacCarthy.

**Manganese Ore at Butte, Mont.**—A reconnaissance of the Butte district was made recently by J. T. Pardee of the U. S. Geological Survey, who reports that the development of manganese ores at Butte has heretofore been wholly incidental to the production of silver, zinc, and lead, in the ores of which manganese minerals are among the chief components of the gangue. Except a few small lots used for fluxing at the smelters, no manganese ore was mined for manganese prior to 1917. As ores containing less than 25 per cent silica are rare in the district, the development of the lodes for manganese has lagged behind that in localities which produce ore of better grade. Systematic exploration of several of the larger manganeseiferous lodes has just begun, and search for pockets of marketable ore is being made in a small way by several lessees. The manganese ore is mostly oxidized and siliceous, and its content of manganese ranges from 10 to 37 per cent, but there are small quantities of high-grade ore, both oxide and carbonate. The main problems to be solved before Butte can become a factor in the manganese market under present conditions are (1) successful milling of the ores to produce a low-silica concentrate, and (2) briquetting the concentrate or otherwise making it acceptable to buyers. Milling tests have already been begun, but the results have not been entirely satisfactory, owing chiefly to losses in the tailings by sliming.

## The Sulphuric Acid Situation in the United States

By LEWIS B. SKINNER\*

**P**RECEDING the declaration of war, sulphuric acid in the United States was made exclusively either from "burner gases," produced in roasting zinc ores (blende) or pyrites, or from blast-furnace gases from the smelting of Tennessee copper ores. The pyrites-burning plants were situated more particularly along the Atlantic Coast, in the Southern fertilizer manufacturing areas, and on the Pacific Coast. Blende-roasting plants were situated in those Middle-Western districts where cheap coal and natural gas are available. In general, pyrites was obtained from three places: Spain, Canada and Virginia. After the war began, the Spanish supply was materially reduced and the Virginia supply has been curtailed as a result of a cave-in and flooding of the Arminius mine, Virginia's principal producer. Consequently a number of manufacturers have found it necessary to burn brimstone instead of pyrites. Fortunately for the United States we have two internal supplies of brimstone which were capable of immediate expansion to several times their former production.

For a while after the war was started the Southern fertilizer plant, with its adjunct of acid chambers, was curtailed in its production of complete fertilizer, and the acid plant was turned over to intense production for sale to powder makers. A number of small chamber plants, which had been built in connection with fertilizer factories, had been shut down before the war because it was commercially cheaper to purchase acid from some of the large producers, such as the Tennessee Copper Company, than to make this commodity on a relatively small scale. When the war demand came on these plants were put in as good shape as was practicable and started up, because, with soaring acid prices, it was quite profitable to operate plants that were almost ready for dismantling.

### PRODUCTION FROM ZINC-ACID PLANTS

The zinc-acid plants also were stimulated with equal intensity in both of their outputs, with the result that every possible arrangement for increased production was resorted to, even though recoveries were not good. Even Hegeler kilns, which are used almost exclusively in the United States for roasting ores in zinc-acid plants and which are known to demand a high amount of oxygen to finish the roast, were arranged to burn brimstone along with ore so as to increase acid production. The normal operation of these kilns for acid making results in the production of a weak gas, so that the chambers in such plants have to take care of an oxygen content far higher than that necessary for the actual chamber reactions. A suggestion to a number of such operators that melted brimstone be fed into the dust flues on top of the roaster, thus utilizing the

otherwise objectionable excess of oxygen and securing greatly increased production for the same sized chamber layout, was followed. This procedure increased the chamber capacity about 20 per cent, other things being equal, and the practice soon spread to all zinc-acid plants. The high prices of zinc and acid prevailing shortly after the beginning of the war stimulated the addition of chambers, retorts and roasters in almost all of the zinc-acid smelters making sulphuric acid as a by-product. With the increased demand from the explosives manufacturers, steel makers, oil refiners and others, the demand for sulphuric acid has seemed to be unlimited and, throughout the war so far, its production has not caught up to the demand.

The zinc smelting plants that are situated in the Kansas-Oklahoma gas belt do not utilize the sulphur gas produced from roasting, because it is commercially practicable to roast by burning natural gas in direct contact with the ore. This practice commingles the products of combustion and the sulphur gas, so that the latter is not available for acid making. Further, it is considered financially risky in this district to make a greater investment than necessary, with short-lived gas pools controlling the situation.

Coal-burning plants, on the other hand, have a much higher investment cost both on account of the need for gas-producer equipment and the necessity for using expensive muffled roasters, or kilns, so as to avoid the relatively high volatilization loss of zinc when burning coal in a "reverberatory" style of working. Since these kilns prevent the commingling of the products of combustion and the bases resulting from the oxidation of the ore, the latter may be used for making sulphuric acid, thus giving us what are called zinc-acid plants.

The sulphur-bearing zinc ores of this country are found mainly in Missouri, Wisconsin, Montana, Colorado, Tennessee and California. With the exception of Tennessee the zinc ores available to our reduction plants came mainly from west of the Mississippi, and freight rates settled the advantageous smelting points near cheap coal supplies in Illinois. The pre-war American market could absorb only a limited amount of spelter, and exportation was impracticable because about 60 per cent of the world's consumption of the metal was more cheaply furnished by Australian ores finding cheap water transportation to Belgian smelters. Zinc acid did not begin to cover the requirements of the United States, but even if the demand for spelter had been such that there could have been a greater coincident production of sulphuric acid, it was practically impossible for a commodity of this low value to be transported any great distance by railroads under existing freight rates. That there have been gradual changes in the geographical location of zinc-acid plants should be noted in a general panoramic view, for two zinc-acid makers have invaded the Pittsburgh district with very large plants, one of them formerly a very large customer of acid manufacturers, and two others

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are now operating in close proximity. Ores from Australia, not being utilized by the Germans just at present, are finding a very satisfactory market at these Eastern smelters. It would seem as if ocean freight rates are such as to allow of a continuation of this business even in normal times.

In the United States brimstone acid is usually the most expensive; that made from lump pyrites is probably second in cost; that from "pyrites fines" is third; while zinc acid is the cheapest. The metallurgy of zinc makes demands upon equipment investment and per-ton cost of handling which is the greatest of any of the ordinary metals. It makes technological demands which leaves the cost of by-product sulphuric acid anything the policy of the company may wish it to be. It is a metallurgical fact that the losses of metal in open roasting as opposed to muffled roasting, using producer gas from coal as fuel, are such that muffled roasting would be desirable even if the resulting sulphur fumes were not utilized. Since muffled roasting in this case is a necessity to avoid volatilization of zinc, a sulphuric acid plant which demands a relatively clean and strong gas naturally follows. Since the roasting has to be done on such a high-priced commodity as high-grade zinc concentrate, it ordinarily really matters little whether the gases are handled to make sulphuric acid or not. The factor that controls this in normal times is that such gases turned into the atmosphere of communities where zinc smelters usually are located would be a nuisance. Other things being equal, it is preferable to avoid trouble. While this fear of committing a nuisance has been a very valuable asset to the United States under war conditions, it will cause some concern when normal times come, because, in order to handle the ores, the gases will be produced and the acid will be made. Some strenuous endeavors will have to be made by sales forces, and, incidentally, traffic departments working with the railroads, in an endeavor to dispose of this by-product acid into a territory which may be expanded in proportion to the expansion that the zinc smelting industry has undertaken as a result of the war stimulus.

#### ACID FROM OTHER METALLURGICAL SOURCES

There has been no material increase of acid capacity in any other metallurgical line than that of burning pyrites bearing valuable metals and that of zinc blende. It should not be considered, however, that pyrites and blende, along with brimstone, are the only sources of suitable gas for acid manufacture. Two of our large copper smelters have been making large tonnages of acid from the fume evolved from blast furnaces. These two companies have used what is called semi-pyritic smelting. Since the war started two installations have been completed where copper ores will be used as the source of supply for the acid gases. Both of these are using easily roasted, high-iron, low-copper, sulphide minerals in a roasting process that is easily comparable with that of ordinary clean iron pyrites.

With the demand for relatively clean and concentrated gas there cannot be much hope for the utilization of lean, dirty gas produced from ores ordinarily handled in lead smelting practice. This would not apply, of course, where part of the ore used could be iron pyrites relatively free from lead. It should be appreciated that the satisfactory roasting of ores for acid

making is a far different proposition than roasting merely to create a desired metallurgical condition. In acid roasting no large excess of air may be allowed to pass through the roaster, and this restriction permits the development of high temperatures which, in the case of leady ores, causes the volatilization of a large part of the metal, whereas in a metallurgical roast large volumes of air are caused to pass through the roaster, so cooling it down to a point which makes such roasting easily manageable.

The large part of the United States demand for acid comes from those states near the Atlantic Ocean and those Southern states in which the soil demands fertilization. To take care of this numerous plants were operated in these areas by burning iron pyrites solely for the purpose of furnishing gas for acid making, using varieties from the sources mentioned before which roast very easily, either in lump burners or in mechanical fines furnaces. By so doing the process of acid making is very simple indeed.

In general it may be said that sulphuric acid can be most easily made by using brimstone and that the difficulties of manufacture increase in the following order:

- (a) Burning clean pyrites in lump burners.
- (b) Burning clean pyrites in mechanical furnaces.
- (c) Roasting sulphide mixtures (i. e., mixtures of iron, lead, zinc, etc., with sulphur).
- (d) Dead-roasting zinc blende in kilns; and, finally,
- (e) Utilizing waste sulphur gases from metallurgical operations with the likelihood that dilution and obnoxious volatile constituents will have to be fought.

Where pyrites was bought for acid-making it was usually purchased on the basis of a price per unit of sulphur, which, at the various points of consumption before the war, probably would average eleven cents. Under the "price per unit" system the given price applies to each per cent of sulphur in the pyrites, and the price per ton of ore is accordingly determined by multiplying the unit cost by the percentage of sulphur as found by analysis.

The "cinder" or roasted ore resulting from burning pyrites was usefully applied in one of three ways: The Spanish cinder was shipped to a chloridizing-roasting copper-leaching plant operated by one of the large acid manufacturing companies; the barren cinder was sent without any further treatment to iron blast-furnaces, where it was more suitably prepared for iron manufacture by being further desulphurized to 0.2 or 0.3 per cent sulphur by blast-roasting; or, was used for road building, complete fertilizer filling, etc. A number of small acid plants were not and are not yet storing this material, which is apparently waste to them, but this practice should not be continued, because there will be a time not far distant, if it is not already here, when a metallurgist can suggest a course of procedure which will show a profit.

#### BRIMSTONE VS. PYRITES

The American demand for sulphur has increased, and strenuous times are at hand at this writing for reasons already given. With so many manufacturers already having changed from pyrites to brimstone burning, it would be remarkable were our brimstone supply elastic enough to take over all the additional load. We are to be congratulated that our Union Sulphur and Free-

port Companies have been able to expand their former output many times.

There are brimstone deposits in Wyoming, near Cody and Thermopolis, but the rock does not occur in large quantities in the individual pockets, nor is it of a sufficiently high grade. It will probably average 30 per cent sulphur in workable deposits.

The substitution of brimstone for pyrites in a number of plants that have been burning the latter has enabled these manufacturers to produce a greater tonnage of acid from a given sized unit. When brimstone is used as a source of sulphur dioxide, the plant investment per ton of acid produced is far less, other things being equal, than when acid is made from pyrites. The reason for this is that the burner construction is much simpler, the gas resulting from brimstone is far richer and so demands less chamber space per pound of sulphur burner than in the case of pyrites. In burning the latter, part of the oxygen entering the roaster, or the lump-burner, as the case may be, is consumed in oxidizing the iron that is a constituent of pyrites. The nitrogen, of course, that enters with this oxygen, passes on with the sulphur dioxide gas that results from the oxidation of the sulphur and acts as a diluent in the burner gas. With brimstone there is no other material to be oxidized, and therefore the air that passes in for oxidation furnishes only a sufficient amount of oxygen for the brimstone itself. Burner-gas from pyrites may carry 8 per cent  $\text{SO}_2$ , whereas that from brimstone may run 12 per cent.

In normal times, and even under the present circumstances, the sulphur in brimstone is more expensive than that in pyrites, but, on account of the lack of boats for the transportation of Spanish pyrites and the accident to the large Virginia supply, the manufacturer has little option to do otherwise than buy the more expensive brimstone. One ton of brimstone will make practically three tons of 66 deg. Be. acid, or four tons of 60 deg. Be. acid. If the brimstone is sold at a cost approximating \$36 a ton delivered, it may be easily computed that this cost alone against 66 deg. acid is approximately \$12 per ton, and that the cost of the brimstone in 60 deg. acid is \$9 per ton. The increased investment and operating cost per ton of 66 deg. acid made from pyrites as against brimstone is approximately \$2 per ton. This would compare now with a pyrites price of approximately 32 cents per unit, calculating for the roaster losses. The differential between brimstone and the sulphur in pyrites is even now, therefore, great enough to permit of the use of pyrites, even though less acid is made in a given plant and even though the plant investment costs more per ton, as rarely is 30 cents per unit asked. In a "speed-up" policy our Government is asking for as large a production as possible, so brimstone is now used as far as possible for patriotic as well as commercial reasons.

#### THE CONTACT PROCESS

A decade or so ago there was quite a controversy among acid makers on the relative merits of the contact and chamber processes. It was even predicted at that time that the chamber process could not long survive and that the contact would be the only one used.

The situation in the country developed as follows: The General Chemical Company secured the American rights for the "Badische" contact process, the New

Jersey Zinc Company for the "Grillo-Schroeder" process, Mr. Wilke of Buffalo, N. Y., for the "Mannheim" process and the Merrimac Chemical Company for the "Tantelewski" process. Sulphuric acid production continued to be largely the result of the use of the chamber process for the reason that the plan of licensing was usually made both onerous and annoying, onerous in that the royalties exacted were relatively heavy, more particularly on the stronger grades of product, and annoying for the reason that most licenses proposed were in such form that the licensor would have every opportunity of learning exactly what the licensee's business amounted to. Since it was not deemed advisable to place this information in the hands of competitors, there was a disinclination on the part of most manufacturers to use the contact process.

Later on, as a result of European litigation, the American rights for all of the four contact processes virtually passed into the control of one company, whose American representative is the General Chemical Company.

#### GENERAL PLANT EQUIPMENT

With acid making tending to pass over to various ore smelters and with fine concentrates from flotation mills and their reduction plants creating clouds of dust in the roaster gases, much money has been spent in an endeavor to adapt the Cottrell precipitation process to handle the gases used for acid manufacture. In the chamber process it is desirable to have the roaster gas remain as hot as possible in its passage to the Glover tower. In roasting material containing iron a small percentage of the sulphur is converted catalytically, under the effect of the roast, to sulphuric anhydride, and this, of course, will combine with the moisture present in the air admitted to the gas, with the result that sulphuric acid will be precipitated in flues if the gas becomes cool. To maintain a lot of metallic parts at red-hot temperature, to avoid the corrosion that takes place when the temperature drops, and to maintain a delicate equipment in commission when either one or the other condition is likely to prevail present difficulties, particularly when one is trying also to prevent the leakage of voltage which is not within the realm of ordinary usage. This has caused the Cottrell scheme to be abandoned in the acid works where it was tried. Some good dust-collector designs, however, have been perfected and are so simple that these may be placed in the hands of the ordinary operator. The manufacture of sulphuric acid by either process, the contact or the chamber process, demands an approximation to that condition which we call "fool-proof," and with this idea the Cottrell does not comply.

Mechanical roasters of the McDougall type have been greatly improved in their ability to avoid "lost time." Numbers of modifications of design permit of use in almost any wide range of metal content in sulphide ores and products. In acid manufacture the ability of this type to conserve heat has driven all but the old Hegeler kiln (for dead-roasting zinc blende) out of the market, and the near future will no doubt see this type slowly displacing even the Hegeler. The construction of the old fashioned lead tower in chamber plants is rapidly giving away to far cheaper masonry designs, and the old crockery pipes, containers, cocks and pipe-lines to the silicon-iron castings.



## VARIETY OF DEMAND FOR SULPHURIC ACID

I can recall no explosive (with one exception, black powder) which does not depend upon sulphuric acid in some form for its manufacture. Of course, all explosives demand nitric acid or nitrates in their manufacture. To take up the water both of the original nitric acid and that formed from the nitration reaction demands the presence of some dehydrating agent. The one found best suited is sulphuric acid. The explosives manufacturer, therefore, is interested in strong sulphuric acid to make nitric acid and as a dehydrating agent. As a result of the war demand there was a tremendous increase of devices for the concentration of the weak acid, resulting from the chamber process, or which is a by-product itself of explosives manufacture. The result is that a great deal of sulphuric acid concentrating equipment was installed in explosives plants, and many hundreds of tons of this material were used to make an excess of nitric over and above any pre-war requirements.

It would be interesting to trace back the effect of the war upon numbers of industries. Take the automobile industry, for instance, and its effect upon the sulphuric acid industry. It is a fact that money made as a result of the stimulus of the war upon manufacturing in the United States has made it possible for a greater percentage of the people to buy automobiles, and these machines demand, of course, more crude oil for fuel and for lubrication. This increased demand along with that of the increased use of oil in the industrial operations for building the cars has resulted in an increased use of the oil resources of the United States. Since sulphuric acid enters largely into the refining of these oils, the acid industry has been called on to measure up to this demand.

If the Southern complete-fertilizer maker had been able to secure potash from some place other than Germany, and southern fertilization had been practised as in normal years, there would have been in the aggregate such a demand for sulphuric acid that there would have been no hope of meeting it. If it had not been for the aid of the Southern fertilizer manufacturer in diverting his acid output from the fertilization of soil to the needs of other industries we would not have had our present industrial activity. The Southern soil, however, cannot weather more than a few seasons of partial fertilization. The increased demand for cotton, both as a result of industrial activity and the manufacture of smokeless power and gun cotton, has forced the Southern cotton grower to wonder what will happen in the coming year if he fertilizes so little as he has for the past two or three years. The three plant foods that are essential in a fertilizer are available potash, available nitrogen and available phosphorus. The only real potash comes from the Stassfurt mines of Germany, although the United States is now producing some low-grade material in Nebraska. We of the United States have the real supply of phosphate rock and in normal times are easily able to make more than enough sulphuric acid to take care of any demand that may be made of its acidulation. With the potash supply from Germany cut off and with the acid supply utilized some other way, the Southern cotton grower has been compelled virtually to do without. This year he is beginning to think that something strenuous should be

done, because high prices of cotton and food make fertilization imperative for the reason that a good yield per acre cannot be hoped for unless some potash and acidulated phosphate rock are supplied to the soil. This in turn will stimulate a further intensified production of acid, if such is necessary, and I rather expect this demand for fertilizer will keep on intensely even though the war will have removed the demand for acid for the making of explosives. In other words, after allowing Southern soil to go for two or three years it will probably take more than the normal yearly supply to rehabilitate it.

Sulphuric acid is one of the raw materials entering into the manufacture of most other chemicals, notably nitric acid, hydrochloric acid, salt cake (which is used in the plate-glass business), blue vitriol, green vitriol, almost all organic preparations, artificial leathers, combs, reclaimed rubber, electrical insulators, etc., and one could indefinitely elaborate upon the effect that new industries and the stimulation of increased activities in all lines of business have had on its production. Suffice it to say that it has all resulted in causing an increase of plant capacity so greatly in excess of what apparently can be used after the war is over that some manufacturers are already concerned. Operators will consider it advisable to keep plants running as long as possible before shutting down since it is well known that an idle sulphuric acid plant deteriorates much more rapidly than does one that is running.

## FUTURE OF THE INDUSTRY

For the future, I think the general trend will be to relegate acid manufacture to those engaged in the metallurgical industry. I think there will be a gradual decline in the practice of pyrites-burning, and incidentally brimstone, for the express purpose of making sulphuric acid. From an economic point of view this would be probable for the reason that it would seem undesirable for one part of the country to be wasting thousands of tons of available sulphur gas while another part is spending millions of dollars for the purchase of sulphur-bearing material, when a large part of the latter comes from a greater distance than would the acid if it came from the point at which it is being wasted. If we could properly impress the railroads with the advisability of hauling this commodity at rates more comparable with those of other commodities used in equal tonnages and having approximately equivalent values, we might secure a better commercial condition. If this equalization is not practicable, I think there will be a general trend of acid-consuming industries toward the territory at which sulphuric acid may be cheaply produced as a by-product in a manner similar to the trend of industries demanding cheap electrical power to the Niagara Falls district.

Denver, Col.

**Shale Oil Reserve for Navy.**—In the annual report of the Director of the Geological Survey, just made public, attention is called to the creation of two naval oil reserves in Colorado and Utah. The Survey has explored large areas in Colorado and Utah that contain immense deposits of such shales, some of which carry 30 to 50 gallons of oil to the ton. The Colorado reserve created for the Navy contains 45,440 acres, and the one in Utah 86,584 acres.

## The Influence of Heat Treatment

### On the Electrical and Thermal Resistivity and Thermo-Electric-Potential of Some Steels\*

BY EDWARD D. CAMPBELL AND WILLIAM C. DOWD

THE principal object of the present investigation—which is far from being complete—was to conduct a preliminary study of the correlation of electric and thermal properties of steels in the light of the solution theory if accepted in the full sense of the term.

Although an apparent connection between thermal and electrical conductance in metals had previously been noted by Forbes, it was the systematic work of Wiedeman and Franze in 1854 which demonstrated the relationship was probably a definite one. If this were the case it would be reasonable to expect both electrical and thermal resistivity in metals might be due to the same atomic or molecular mechanism. Although numerous investigators studied the relation existing between electrical and thermal resistivity in metals subsequent to Wiedeman and Franze's publication, it was the exhaustive work of Jaeger and Diesselhorst which demonstrated that the ratio of the electrical to the thermal resistivity is approximately constant for pure metals, but does not hold equally well for impure metals or alloys. In 1897 Schulze<sup>1</sup> measured the thermal and electrical conductivities of five carbon steels and one manganese steel, and showed that the Wiedeman and Franze law did not hold in the case of these metals. It is now generally conceded that the Wiedeman and Franze law—that is, the ratio of the electrical to the thermal resistivity in absolute units—holds quite closely for pure metals, being about  $6.5 \times 10^{-10}$ . It does not, however, hold very closely for impure metals or alloys, although in general any marked change in electrical resistivity is accompanied by a corresponding change in thermal resistivity. During the past twenty years physicists have carried out a great number of experiments in order to determine with increasing degree of accuracy the correlation of electrical and thermal resistivity in metals, with special view to the influence of the temperature at which the measurements were made on this relationship. In almost all this work metals or alloys of metals other than iron were employed. Very few, if any systematic measurements of the thermal resistivity of steel have been made, although the fact that there is a close relationship between the chemical constitution and electrical resistivity of steel has been recognized for more than fifty years, and has served as a basis for many researches.

Although the solution theory of metals, as it is now termed, was first advanced more than a century ago, to the great majority of physicists and metallurgists the term is almost a meaningless phrase, since they still refuse really to accept as a mental concept the essential unity of mechanism of metallic and aqueous so-

lutions. They all recognize and take into account the part played by the solvent as differentiated from that played by the solute in ordinary solutions, and yet, when studying the properties of metallic solutions, many of them refuse to recognize the essential unity of mechanism, and make little or no effort to differentiate between the part played by the solvent and that by the solute. It would seem entirely possible that, if metallic solutions were regarded from exactly the same viewpoint as ordinary solutions, reasonable explanation for many well-known phenomena might be found which cannot be satisfactorily explained in any other way.

In 1915 one of the authors<sup>2</sup> gave experimental evidence to substantiate the conception that total electrical resistivity of steel must be considered as made up of two components—first, that due to the solvent, and, second, that portion due to the carbides in solution; the effect of these latter on the electrical resistivity being proportional to the concentration of the carbides actually in solution. It was there suggested that, as in aqueous solutions, it is the molecules in solution which are capable of reacting with different forms of energy, and consequently the electrical resistivity would be dependent on the molecular concentration of the carbides in solution, since by their reactivity these carbides would cause electrical energy to disappear as such and reappear in the form of heat.

In a later paper<sup>3</sup> the dependence of the electrical resistivity on the concentration of the carbides in solution was confirmed, and it was further shown that if carbides are the only solutes present in noticeable amounts the thermo-electric potential due to dissolved carbides is a function of the concentration. In these same papers it was further shown that electrical conductance is almost entirely through the solvent, while electrical resistivity is only in part due to the solvent, frequently as much as 80 per cent or more of the total resistivity being due to the solutes in solution.

#### EXPERIMENTAL

The experimental bars used were all machined down to a uniform size of 6 mm. square by 15 cm. in length from stock samples of larger bars furnished by the courtesy of the same companies which have supplied us with bars on our previous work. The composition of the steels used in the present research is given in Table I.

In annealing the steels used, a number of sample bars were usually packed in an electrically heated furnace in such a way as to avoid oxidation, and the temperature raised overnight to that stated as the temperature from which each sample was annealed, after which the furnace was allowed to cool for twenty-four hours and

\*A paper read at the annual meeting of the Iron and Steel Institute, London, Sept. 20, 1917.

<sup>1</sup>Annal. Phys. Chem., vol. 63, p. 23, 1897.

<sup>2</sup>Journal of the Iron and Steel Institute, 1915, No. II, p. 163.

<sup>3</sup>Journal of the Iron and Steel Institute, 1916, No. II, p. 268.



TABLE I—COMPOSITION OF STEELS.

Steel.	Carbon per Cent.	Manganese per Cent.	Phosphorus per Cent.	Sulphur per Cent.	Silicon per Cent.	Copper per Cent.	Nickel per Cent.	Chromium per Cent.
IN1	0.018	0.016	0.005	0.018	.....	0.018	.....	.....
H57	0.51	0.11	0.010	0.020	0.17	.....	.....	.....
INC	1.184	0.116	0.005	0.018	.....	0.018	.....	.....
C5	0.945	0.189	0.014	0.016	0.155	.....	.....	.....
H1	0.18	0.67	0.007	0.019	0.16	.....	3.45	.....
M8	0.326	0.405	0.013	0.025	0.162	.....	4.48	.....
H6	0.14	0.44	0.009	0.008	0.11	.....	4.12	1.61
SN1	1.110	0.40	0.020	0.038	1.20	0.06	0.31	0.348
SN3	0.104	0.122	0.03	0.025	3.649	.....	.....	.....
MN1	1.150	1.157	0.055	0.023	0.25	.....	.....	.....

the large sample bars removed. It was from the sample bars thus annealed that the small experimental bars used for quenching were machined. All temperatures, whether of annealing or quenching, were measured by means of standard platinum-rhodium thermocouples standardized at intervals against the melting point of pure silver taken at 961 deg. C.

The method of hardening the small bars was essentially the same as that employed in this laboratory for some years and described in detail in 1915.<sup>4</sup> The bars to be quenched were suspended in an electrically heated furnace so designed that, no matter how long they were kept in the furnace, there was no oxidation, and carburization, if occurring at all, did not exceed 0.02 per cent. The bars were kept in the heated chamber as a rule one hour, the temperature being measured by a thermocouple placed 2 to 3 mm. from the bars under treatment. The quenching bath was a large volume of ice-water, and, as in our previous work, the time required a bar from the furnace to the quenching bath was a little less than one second, the same amount of time being required to cool the bar from the quenching temperature to below a red heat. Experience in this laboratory has tended to show that bars which are perfectly clean and bright cool somewhat more quickly on quenching than the same sized bars which have been heated in a fused salt bath. These latter, on withdrawing from the heating bath, are covered with a thin film of fused salt which appreciably retards the cooling effect of the water. Enough bars of each kind of steel were quenched to enable the specific resistivity and thermo-electric potential to be measured at the same time. Thermal resistivity was measured on one of these bars after the other measurements had been made. After all the bars had been quenched they were carefully polished and the measurements of specific resistivity, thermo-electromotive force, and thermal resistivity, made with no more delay than was necessary. Numerous experiments in this laboratory have shown that, on account of the instability of the solid solution produced by quenching steel in cold water the specific resistivity and correlated properties will fall off very appreciably even at room temperature within a comparatively short time.

The specific resistances were measured in all cases on bars kept immersed in an oil bath and maintained at a constant temperature of 25 deg. C. The method of determining specific resistance was the same as that heretofore employed, that is, by measuring the fall in potential between knife-edges clamped to the bar 10 cm. apart, while a current of constant density was flowing through the bar.

On account of the rapid change in chemical constitution of hardened steel with increase of temperature it was thought best to make the measurements of specific resistances, thermo-electromotive potential, and thermal resistivity without allowing the temperature of the bars at any time to exceed 35 deg. C. or 40 deg. C. The thermo-electromotive force measured, therefore, was that due to the temperature gradient between 0 deg. C. and 25 deg. C. The method employed was a modification of the one used a year ago and described in detail in one of our previous papers.<sup>5</sup> In the method used in the present work three bars of the same steel and subjected to the same heat treatment were clamped together to form a triple compound bar, to the ends of which were attached, by means of pure iron clamps, the annealed ingot iron leads connecting the ends of the compound bar with the galvanometer by means of which the potential was measured. One end of the compound bar was maintained, as in our previous work, at 0 deg. C. by means of crushed ice, while the other was immersed in the same oil bath as that used for specific resistivities, which was maintained at 25 deg. C. Thus the thermo-electromotive force, measured and expressed in microvolts, represents the difference in thermo-electromotive potential of the steel in question and pure iron over the temperature gradient from 0 deg. C. to 25 deg. C.

As the work herein described is in a sense a preliminary study of the correlation of electrical and thermal resistivities without any attempt to determine the absolute relationship, the thermal resistivities so far determined have all been relative, that of pure ingot iron being taken as unity. It is hoped that later new determinations of thermal resistivities will be made with improvements in the apparatus which will enable such measurements to be made under more favorable conditions, and with a higher degree of precision, so that the results may be reduced to absolute units. The method employed of measuring the relative thermal resistivities herein given was one of the stationary temperature type, the technique of which was developed under the direction of Dr. Carelton V. Kent of the Department of Physics. The detailed description of this method of Dr. Kent is given in the *Physical Review* of 1917.

The method of determining the relative thermal resistivities is briefly as follows: The bars, 6 mm. square and 15 cm. in length, are provided with two holes a little more than 1 mm. in diameter and 4½ mm. in depth, one hole being 5 mm. from the cold end of the bar and the other 10 cm. from the same end. These holes are for the insertion of fine copper-constantan thermocouples, by means of which the difference in temperature between each of the holes and the surrounding space is measured. The holes were filled with paraffin oil before inserting the thermocouples; a better thermal contact being thus obtained between the couple and the steel than when the oil was not used. About 3 cm. of one end of the bar was inserted in a small heating oil by means of which the temperature of the bar at the hot end could be easily raised and maintained constant for any desired length of time. The bar, supported in the heating coil and with thermocouples in position, was inserted into the center of a heavy steel

<sup>4</sup>Journal of the Iron and Steel Institute, 1915, No. II, p. 164.<sup>5</sup>Journal of the Iron and Steel Institute, 1916, No. II, p. 268.

cylinder, 20 cm. inside diameter and 40 cm. long, and closed at the inner end with a heavy steel plate. This steel cylinder was, in turn, boxed in, in order to avoid local air currents. The mass of the metal—something more than 20 kilograms—was sufficient to maintain reasonable constancy of temperature throughout the interior during a given experiment. After a bar whose thermal resistivity was to be measured had been inserted into the steel cylinder, a current was turned on through the heating coil until the thermocouple showed a rise of about 10 deg. C. The copper-constantan thermocouples used were made of very fine wires, each being calibrated against a standard thermometer. The couples gave a deflection of about 6 mm. per each degree, so that temperatures could be readily measured to within less than 0.05 deg. C. Since all bars were of the same dimensions, the thermocouple holes were the same distances from the cold end in every case, and the temperature of the higher point of measurement was substantially constant in all cases, the difference in temperature at the cold and hot points of measurement must have been directly dependent upon the thermal resistivities of the bars. Usually from 1½ to 2 hours were required for the system to come to equilibrium. When this had been attained, the ratio of the temperature difference at the hot and cold ends of the bar was calculated. Dr.

Kent has shown that the ratio  $\frac{\theta_1}{\theta_2} = \cos aL$  in which

simplified equation  $a = \sqrt{\frac{hp}{cq}}$  where  $h$  is the heat lost

to the enclosure from 1 sq. cm. of the surface per degree excess temperature,  $p$  is the perimeter,  $c$  is the conductivity and  $q$  is the cross-section of the bar. From mathematical tables giving hyperbolic functions  $aL$  may be found from the experimentally determined

temperature ratio  $\frac{\theta_1}{\theta_2}$ . Since we are interested in the reciprocals of the conductivity or the resistivity, the

relative resistivities may be easily found from the  $(aL)$  as  $h, p, q$ , and  $L$  the distance between the hot and cold points of measurement, are the same for each bar. The resistivities would, therefore, be directly proportional to the square of the  $(aL)$ .

The results of the measurements of the specific resistance at 25 deg. C., of the relative thermal resistivity, and of the thermo-electromotive force of the nine steels in the annealed condition, are given in Table II, in which the steels are arranged in order of increasing specific resistance. In this table is also given the specific resistance of the pure ingot iron, which is taken as unity in the determination of relative thermal resistivities and which is also used in opposition to the different steels when determining the thermo-electromotive potential. The small numbers in parentheses following the names of the steels as given in Table II serve to identify the points corresponding with each steel, as shown graphically in Figs. 1 and 2.

TABLE II.—TABLE SHOWING SPECIFIC RESISTANCE RELATIVE THERMAL RESISTIVITY, AND THERMO-ELECTROMOTIVE POTENTIAL OF ANNEALED STEELS.

Steel.	Temperature of Annealing.	Specific Resistance in Microhms.	Relative Thermal Resistivity.	Thermo - Electromotive Potential against Ingot Iron in Microvolts.
	Degree C.			
INI (1)	778	10.64	1	...
H57 (2)	903	15.28	1.25	116
INC (3)	960	15.90	1.35	90
C5 (4)	903	18.05	1.47	128
H1 (5)	700	25.16	1.99	310
M8 (6)	...	25.36	2.03	371
H6 (7)	718	32.24	2.38	232
SN1 (8)	950	41.58	2.84	362
SN3 (9)	985	53.37	3.17	556
MN1 (10)	810	54.25	3.78	334

In Table III are given the corresponding measurements made on the same steels as those given in Table II, but with the steels in the quenched or hardened condition. The steels are again arranged in order of increasing specific resistance, but it will be noted, from the small figures in parentheses following the name of each steel, that the order of arrangement of

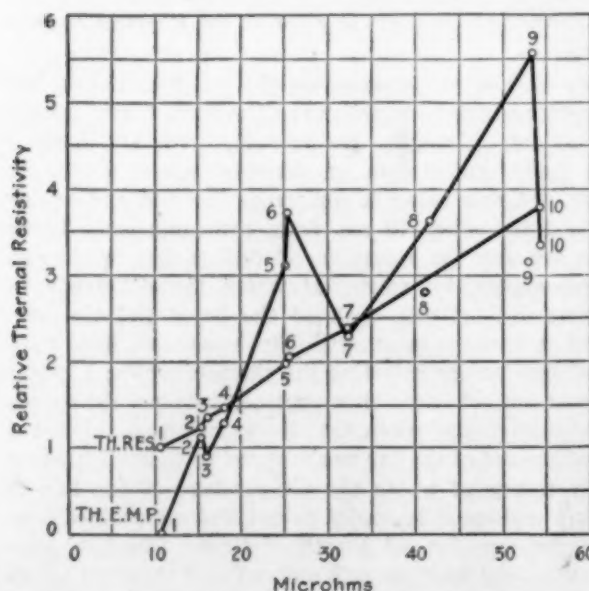


FIG. 1.—THERMAL RESISTIVITY AND THERMO-ELECTROMOTIVE POWER OF ANNEALED STEELS

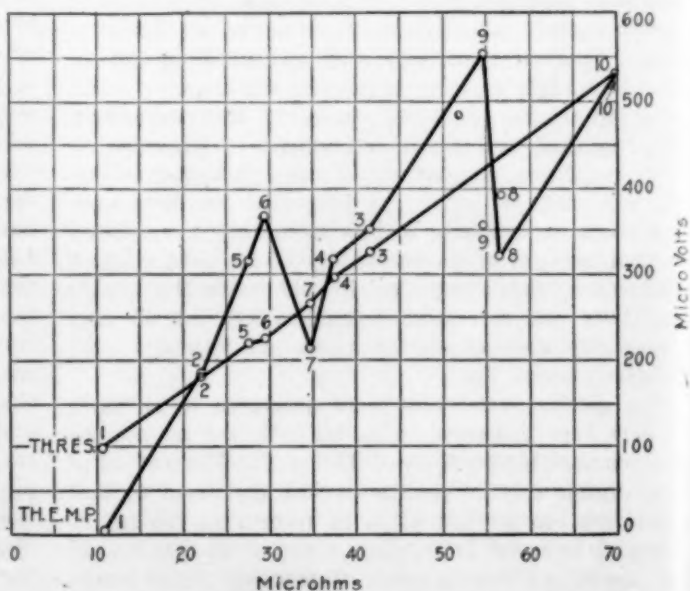


FIG. 2.—THERMAL RESISTIVITY AND THERMO-ELECTROMOTIVE POWER OF QUENCHED STEELS



the steels in the hardened condition is quite different from what it was when the steels were annealed.

In order to bring out the correlation of the thermal and electrical resistivities as influenced by chemical constitution and heat treatment, the results of the measurements given in Tables II and III are shown graphically in Figs. 1 and 2. In these the specific resistances in microms are shown on the abscissæ, while the corresponding relative thermal resistivity and thermo-electromotive potentials are shown on the ordinates. It will be noted that the curve of relative thermal resistivity is approximately a straight line except for two points, 8 and 9, of the steels SN1 and SN3, both of which are high silicon steels, the silicides apparently giving a distinctly higher ratio of electrical to thermal resistivity than do carbides or other solutes.

TABLE III.—TABLE SHOWING SPECIFIC RESISTANCE, RELATIVE THERMAL RESISTIVITY, AND THERMO-ELECTROMOTIVE POTENTIAL OF HARDENED STEELS.

Steel	Temperature of Quenching.	Specific Resistance in Microms.	Relative Thermal Resistivity.	Thermo-Electromotive Potential against Ingot Iron in Microvolts.
	Degrees C.			
INI (1)	Annealed	10.64	1	...
H57 (2)	902	22.08	1.85	186
H1 (5)	902	27.74	2.22	318
M8 (6)	830	29.72	2.27	...
	900	...	...	368
H6 (7)	830	34.77	2.68	216
C5 (4)	830	37.41	2.99	...
	902	...	...	320
INC (3)	830	41.64	3.27	...
	902	...	...	352
SN3 (9)	902	54.72	3.57	556
SN1 (8)	830	56.38	3.93	324
MN1 (10)	902	69.80	5.35	534

A study of the data given in Tables II and III, and of the curves shown in Figs. 1 and 2, reveals some interesting relationships, especially if viewed in the light of the solution theory of steel accepted in the full sense of the word. If steel is regarded as made up of a solvent and solutes, we may get an approximate idea of the relationship of that portion of the electrical resistivity due to solutes, to that portion of the thermal resistivity to solutes by subtracting from the total specific resistance of pure iron (10.64), and, from the total relative thermal resistivity, that of pure iron (1.00), and then finding the ratio of the electrical resistivity to the relative thermal resistivity. The ratio of the electrical resistivity to its relative thermal resistivity of pure iron would, of course, be 10.6. If, in the case of the annealed steels, we calculate by the method above just suggested—the ratio of the electrical resistivity to the relative thermal resistivity—we find this varies from 14.3 to 19.7 in the case of SN3, in which the solute is almost entirely silicide. In the case of the hardened steels the ratio of the electrical resistance to the relative thermal resistance due to solutes varies from 13.4 to 17.4, the highest ratio again being due to that of SN3, containing the highest concentration of silicides. These ratios are all noticeably higher than the ratio found in the case of pure iron solvent and confirm what has been known for many years—that the Wiedeman and Franz law does not hold in the case of impure metals or alloys, the electrical resistivity of such metals increasing more rapidly than the thermal resistivity. In all the steels under examination the effect of quenching has been to increase both the electrical and thermal resistivity, the extent of this change being closely connected with the percentage of

carbon in the steels. This would be expected, since it is the carbides which precipitate from solution when the steel is annealed and again pass into solid solution when heated above Ac<sub>3</sub> just before quenching.

In 1916<sup>a</sup> a hypothesis to account for electrical resistivity in steels was advanced. This hypothesis assumed the essential unity of mechanism of solid solutions and of aqueous solutions, and attributed that portion of the total specific resistivity due to carbides in solution to the transformation of electrical energy into heat, this transformation being due to the fact that it is those molecules in solution that are most reactive toward any form of energy. If heat is assumed to be made up of two forms of motion, one portion being electronic and the rest atomic or molecular motion, we might easily find a reasonable explanation for the correlation between electrical and thermal resistivities based on the solution theory in the full sense of the word. If molecules of solutes in solution are capable of reacting with electrical energy and transforming a portion of this electronic motion into atomic or molecular motion, thus producing electrical resistivity, it would be only reasonable to expect that the same molecules in solution which could transform electronic motion of electricity would also be capable of transforming that portion of heat which exists as electronic motion into atomic or molecular motion. Under this conception we would expect a close relationship between the electrical and thermal resistivities of steel, since they both become dependent upon the chemical constitution.

When carbides are the only solutes present to any considerable extent it was shown in the paper before referred to that there is a parallelism between the thermo-electromotive potential of these carbides and the specific resistance, both being dependent on the concentration of the carbides in solution. From the curve of the thermo-electromotive potential shown in Figs. 1 and 2 it will be evident that the thermo-electromotive potential is dependent upon the chemical composition of the solutes as well as on the concentration. Under the conception of the essential unity of mechanism of metallic and aqueous solutions, the assumption that the thermo-electromotive potential of solutes in solid solution is exactly analogous to the solution tension of electrolytes in aqueous solution would offer a simple explanation for the changes in thermo-electromotive potential due to differences in chemical composition and heat treatment. If a cell be set up with an aqueous solution of a single electrolyte A, the electromotive force of such a cell will be dependent on the chemical composition and concentration of the electrolyte. If a second cell be set up with an electrolyte B, of higher solution tension than A, the electromotive force of the second cell will be higher than that of the first for a given concentration. If a cell be set up with a mixture of these electrolytes, A and B, the electromotive force of such cell will not be additive, but will be intermediate between that of A and B, never reaching as high as when B alone is present. An exactly analogous change will be found in the thermo-electromotive potential of steels when the concentration of the solutes in solution is changed by heat treatment. When the thermo-electromotive potential of the solute

<sup>a</sup>Journal of the Iron and Steel Institute, 1916, No. II, p. 268.

in solution, other than carbides, is higher than that due to carbides in solution, the thermo-electromotive potential of such steels in the hardened condition tends to be lower than that of the same steel annealed, since in the annealed condition the carbides are very largely precipitated. This is most strikingly illustrated in case of SN1, where we find a distinct drop in thermo-electromotive potential brought about by quenching, although the specific and thermal resistivities are both markedly increased due to the increased concentration of the solutes in solution.

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### Chemical Alliance Succeeds Chemical Committee of Council of National Defense

With the dissolution of the committees of the Council of National Defense, a plan was submitted to the authorities in Washington, whereby the Chemical Alliance, Inc., would take over some of the work of the Committee on Chemicals and its various sub-committees. The Chemical Alliance was originally formed last August to take up certain matters in connection with fertilizers and pyrites importation.

The officers and directors of the Chemical Alliance, Inc., were all members of the Chemical Committee.

Rather than resolve the various sub-committees of the Chemical Committee into separate and distinct trade committees, it seemed advisable to the Chemical Committee at the time of the dissolution of Council of National Defense committees to try and hold its organization intact, and the Chemical Alliance, Inc., seemed to offer the best medium for the accomplishment of this purpose.

Dr. William H. Nichols, chairman of the Committee on Chemicals and president of the Chemical Alliance, Inc., resigned from the presidency of the Alliance, and Horace Bowker, vice-president of the Chemical Alliance, Inc., was elected president. Henry Howard, chairman of the executive committee of the Manufacturing Chemists' Association, was elected vice-president. J. D. Cameron was elected treasurer and secretary pro tem. The directors of the Chemical Alliance, Inc., are as follows: Dr. William H. Nichols, General Chemical Company, New York City; Horace Bowker, American Agricultural and Chemical Company, New York City; E. R. Grasselli, Grasselli Chemical Company, Cleveland, Ohio; J. D. Pennock, Solvay Process Company, Syracuse, N. Y.; William Hamlin Childs, The Barrett Company, New York City; D. W. Jayne, The Barrett Company, New York City; C. H. MacDowell, Armour Fertilizer Works, Chicago, Ill.; C. G. Wilson, Virginia-Carolina Chemical Company, Richmond, Va.; John J. Riker, E. D. & J. J. Riker Company, New York City; F. A. Lidbury, Oldbury Electro-Chemical Company, Niagara Falls, N. Y.; A. D. Ledoux, Pyrites Company, Ltd., New York City; Henry Howard, Merrimac Chemical Company, Boston, Mass., and Edward Mallinckrodt, Jr., Mallinckrodt Chemical Works, St. Louis, Mo.

The offices of the Alliance, Inc., for the present will be 538 Woodward Building, Washington. Telephone, Main 9946.

The sub-committee on fertilizers of the Committee on Chemicals now becomes the committee on fertilizers of the Chemical Alliance, Inc., with offices and telephone number as heretofore.

The Chemical Alliance, Inc., is now not a Government committee, but acts in an advisory capacity to the Government in collecting data, making recommendations, etc. The actual buying of chemicals, explosives, etc., is in charge of Mr. L. L. Summers, whose office is in the Council of National Defense Bldg. This arrangement should work out very satisfactorily to all concerned.

## Acidity Determination in Water, Leach Liquors, Mine Waters, Etc.

BY JAMES J. RANKIN

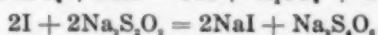
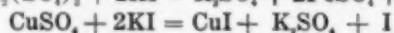
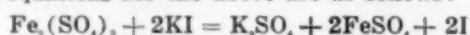
Assistant Chemist, Research Dept., Phelps Dodge Corporation

THE following method for determining acidity in the presence of sulphates of ferrous and ferric iron, copper, aluminium and manganese is new and is, we believe, much more accurate than the usual titration methods.

The objection to titrating solutions containing ferric iron and copper with  $\text{Na}_2\text{CO}_3$  is that the ferric iron and copper interfere by giving a more or less indefinite end-point which does not represent the true acidity due to free sulphuric acid. This new method gives a sharp end-point in titrating which corresponds to the true free sulphuric acid present. The presence of aluminium salts in amounts usually found in waters, leach liquors, etc., does not interfere, especially in the presence of ferrous iron.

The method depends on the preliminary reduction of ferric to ferrous iron, and of copper to cuprous iodide, by the addition of potassium iodide, and the subsequent change of the free iodine formed to sodium iodide by the addition of the requisite amount of sodium thiosulphate, after which the ordinary titration with  $\text{Na}_2\text{CO}_3$  is made.

The equations for the above are as follows:



There is needed for carrying out the method:

1. Potassium iodide C.P. (solution or crystals).
2. Solution of sodium thiosulphate, about 10 per cent or any convenient strength, which need not be standardized.
3. Standard sodium carbonate solution. Strength depends on the percentage of acid in the solution to be titrated, and may be anywhere from  $N/5$  to  $N$ .
4. Methyl orange.

The following is a description of the details of the method.

A definite volume of the solution to be titrated is measured out. This volume will vary widely with different conditions, being dependent on the acidity of the solution and the quantity of salts present, and may therefore be anywhere from 5 to 500 cc.

Dilute to 250 cc., if the solution has not already this volume, and add an excess of potassium iodide. When copper is present there will of course be a precipitation of cuprous iodide and formation of free iodine.

Add sodium thiosulphate in amount sufficient nearly but not quite to neutralize the free iodine present. Then either filter off cuprous iodide and wash three or four times with cold water or dilute to a definite volume, settle and take an aliquot part for determination.

To the filtrate or aliquot part add a slight excess of sodium thiosulphate as measured by the disappearance of the yellow color due to free iodine. When Cu is not present no filtration is necessary after adding KI, and a slight excess of sodium thiosulphate is then added directly.

The solution will now be colorless or practically so,

and after addition of methyl orange may be titrated as usual with standard sodium carbonate solution.

The accuracy of the method is shown by the following experiments:

Ten grams of ferrous ammonium sulphate were dissolved in water, and the ferrous iron oxidized to ferric by the addition of just sufficient potassium permanganate in the presence of a known excess of sulphuric acid. The excess acid was then determined by the above method.

Excess acid actually present = 1.930 gm.

Excess acid actually found = 1.918 gm.

It would have been very difficult to have correctly determined the excess acid in the above solution by the ordinary  $\text{Na}_2\text{CO}_3$  titration, due to the formation of basic ferric sulphate.

For testing the method on leach liquors a solution was made up carrying ferrous and ferric iron and copper in the amounts usually present in such liquors. The amount of free sulphuric acid present was 0.710 lb. per 1000 gal. The amount found by using the above method was 0.706 lb. per 1000 gal., and by the ordinary  $\text{Na}_2\text{CO}_3$  method 0.915 lb.

In another test 0.91 lb. per 1000 gal. was actually present, and 0.90 lb. per 1000 gal. was found by the above method. The ordinary  $\text{Na}_2\text{CO}_3$  titration gave 1.14 lb. per 1000 gal. The new method is accordingly more accurate than the ordinary titration with sodium carbonate.

Another test was made by the new method on a solution containing about 5 per cent each of manganous sulphate, ferrous iron, ferric iron, aluminium sulphate and copper sulphate. The amount of free sulphuric acid actually present by addition to this solution was 3.93 per cent. There was found by the new method 3.97 per cent. This solution would have been very difficult to titrate by the usual sodium carbonate method.

Another test was made to determine the effect of aluminium sulphate. It was found that aluminium sulphate did not appreciably interfere provided considerable ferrous iron was present, as the following one of several tests will show. A solution containing by actual addition 1.29 per cent  $\text{H}_2\text{SO}_4$  and 0.5 per cent  $\text{Al}_2(\text{SO}_4)_3$  was made. The acid was then determined in 300 cc. of this solution with  $N$   $\text{Na}_2\text{CO}_3$  and methyl orange. It was found to be 1.45 per cent  $\text{H}_2\text{SO}_4$ , an increase of 0.16 per cent due to the hydrolysis of aluminium sulphate. Another portion of 300 cc. to which 1.3 per cent of ferrous sulphate had been added was now titrated and 1.29 per cent  $\text{H}_2\text{SO}_4$  was found, the correct amount. This may be explained as follows. At the end-point, the free acid having been neutralized, the ferrous iron begins to oxidize and precipitate, hiding the slightly reddish color of the hydrolyzed aluminium salts. Other sulphates were not found to have this effect.

From the above it seems advisable when titrating solutions containing alumina and little or no iron to add ferrous sulphate before titrating.

The acidity due to the hydrolysis of the aluminium sulphate present can be determined also and a correction factor applied to give the true free acid if necessary.

Chlorides and nitrates have not been found to interfere.

New York, N. Y.



## Synopsis of Recent Metallurgical and Chemical Literature

**Palmerton Zinc Refractories.**—A paper describing the manufacture of spelter vessels, condensers and fire-brick at the Palmerton pottery was presented at the St. Louis meeting of the A. I. M. E. by C. P. FISKE of the New Jersey Zinc Co., Palmerton Works. The bond clay is furnished from St. Louis by the Grand View Fire Clay Co. Several kinds of grog have been used, but calcined flint from the Clearfield district of Pennsylvania has given the best results. Pulverized petroleum coke is also a constituent. The Palmerton pottery is a large and well equipped plant, and can turn out large quantities of retorts, muffles and condensers. The author gives a complete description of their manufacture. The fire-brick made are used principally in the spelter furnace laboratory. As to the qualities desired, the author gives some pertinent points. Theoretically, he says, the perfect vessel should have a maximum heat conductivity, refractoriness, mechanical strength and toughness, and a minimum (or no) porosity and coefficient of expansion. At the same time it should be sufficiently strong when dried to allow handling without undue breakage, and should be chemically inert to the various slags which the gangue in the different types of zinc ores produce. Materials which possess all these desirable qualities are, unfortunately, still to be discovered.

"There are many beds of clay in this country whose refractoriness is amply high. The author has examined and tested many such clays which have exceeded the St. Louis clay in refractoriness, usually to find their shrinkage too high or their toughness too low, or both. Although the combination of St. Louis clay and calcined flint gave the best results of any yet tried, there is still much to be desired. The porosity of this mix, when burned, averages about 6.5 per cent. This figure is found by determining the amount of water the mass will take up in 12 to 15 hr., and where water will penetrate in this time zinc vapors and slag will penetrate during service. This is obviously detrimental to vessel life and spelter practice.

"The purpose of calcined grog in the mix is mainly to lessen the shrinkage of the mass as a whole, by introducing a material which has a much lower shrinkage than that of the bond clay. This in itself produces an undesirable effect, for the bond clay still performs its normal shrinkage during burning, and as it must shrink around the grog particles having a much lower shrinkage, minute cracks are opened up which account largely for the porosity found. A one-material vessel, then, should be more satisfactory, or if cost considerations made two or more materials desirable, they should all have the same shrinkage. As a matter of fact, this latter condition is hardly obtainable, as the drying of the bond clay produces shrinkage which in all probability is partially responsible for this porosity.

"We have at times made vessels containing refractories manufactured under various trade names, but so far without sufficient success to warrant the additional cost of the materials.

"One feature that is probably largely responsible for a certain slowness in developing improvements in vessel manufacture is the difficulty in obtaining conclusive tests. A considerable period of time must necessarily elapse between the first steps in the production of an experimental batch and its final trial in the furnaces, and there are so many factors that may influence the results that it is often difficult to decide just what has been accomplished. Operating difficulties may affect the period of rotting and drying, labor conditions at the spelter furnaces may change, ores may change more or less in their character, and so on almost without limit, as those who have tried probably know. Furthermore, such experiments must be handled with caution, for ill-advised innovations are likely to prove very costly.

"The time required for the manufacture of spelter vessels

is a further handicap to the pottery man in determining sources of trouble under ordinary operating conditions. A batch of muffles may at times fail after an unusually short life, or may exhibit certain unusual features which are undesirable, but a search for the cause is usually fruitless. A few months ago some of our muffles showed a peculiar blistering on the outside after firing in the kilns, and there were as many opinions given regarding the cause as there were people qualified to express an opinion. A careful search was made to obtain some clue as to the cause, but without avail, and in a short time the trouble disappeared, leaving us as much in the dark as ever.

"If the perfect material is discovered, pottery men will not be slow in making use of it. In the meantime efforts must be directed toward a judicious selection of the materials obtainable, balancing their good qualities against those which would be detrimental to retort service, together with improvements in their combination and treatment."

**Japanese Chemical Notes.**—The November, 1917, issue of the *Chemical Technology* gives some data on recent developments in Japan. There are now almost 50 companies making dyestuffs and intermediates, and there is developing considerable competition in some lines. Fuming sulphuric acid is being made on a greatly increased scale. Formic, citric, and oxalic acids are made in considerable quantity, and tartaric acid is also being made. The necessity of making chemical machinery and apparatus is being realized, and has been taken up by one concern. Successful experiments have been made in the production of glycerine from fish waste. The Chemical exhibition was a great success, and was visited by the Emperor, Empress, and others of the nobility who are encouraging the industry.

**Leather Conservation.**—At the third regular meeting of the New York Section of the American Chemical Society on Dec. 7, Dr. ALLEN ROGERS of Pratt Institute, Brooklyn, discussed the subject of leather conservation. His remarks were as follows:

During the past ten years there has been a slow but constant falling off in hides and skins, which has resulted in a gradual decrease in the production of leather. This shortage in raw stock, with the increased demand for leather products, has thus caused a rise in price of all classes of leather. This country has depended very largely upon European markets for its hides and skins, consequently with this source cut off, due to embargo and non-production, the prices have taken extraordinary bounds. To add to the seriousness of the situation, we find ourselves confronted with a shortage in domestic beef animals, and not having an adequate merchant marine, we are unable to reach the South American markets where large quantities of hides and skins are available.

This condition of affairs is deplorable, especially as the United States leads the world in the production of leather. What cannot be cured, however, must be endured. Although conditions in the leather trade are not so serious as they were a year or so ago, we must use every effort to conserve our resources and patiently await the day when a more efficient marine service will bring the markets of the world to our doors.

As the price of any commodity rises, substitutes are bound to appear. This has been true in the case in hand. Not only have leather substitutes been brought forward, but sources of raw material, formerly waste products, have come to the attention of the tanners, and are being worked up into merchantable leather. Processes also are now being employed which aim to produce a leather having a greater wearing quality than in previous years. Some of the processes are

not new, but at the time they were proposed did not meet with favor by the trade. The reason for the lack of interest was due to the fact that the supply of hides was more plentiful than to-day and tanners did not care to change the process to conform to the new method.

In 1911, the speaker, working in conjunction with another member of this Section, developed a method for producing an indestructible sole leather. This leather was tested out on twenty mail carriers and twenty policemen in New York, using it on the right foot with the best oak sole on the left foot. Two oak soles went through and in most cases they were on the third before the new leather wore out. Shoe manufacturers and tanners did not seem interested at that time, but within the past two years several concerns have started to make the leather and it is now being advertised quite extensively.

The skins of fish have been tanned for many years, but only for fancy articles. To-day, however, shark skins, porpoise, and even gray fish and eel skins, are being converted into very serviceable leather. The shark skins have a very hard grain, but the flesh side lends itself to a finish which bids fair to make it a close competitive of box calf or oil grain. Shark skin leather is very tough and serviceable, which makes it well adapted for children's shoes, especially for boys' knockabouts. Gray fish and eel skins are thin, but can be used for fancy leather and small articles.

For many years the waste shavings and trimmings were burnt under the boiler. To-day, however, they are saved by mixing with pulp and put into leather board for insole work.

A recent invention proposes to work up small trimmings from light leather into a thread or yarn, and then use this yarn in weaving leather fabric. Such fabrics may be used for furniture, automobile leather, rugs, and fancy articles.

The heads or pates of hides formerly went into glue stock; to-day, however, these are being tanned and can be bought in the "Five and Ten" as half-soles and heels at ten cents a pair.

In the production of automobile leather the hide is cut up into sections or splits. As a hide can have only one grain side, the other cuts or splits are treated with a dope finish consisting of gun cotton and castor oil, to which a pigment is added. These splits are then embossed and given the appearance of a full grain.

The manufacture of imitation leather is an American idea and has developed into an enormous industry in recent years. This product consists of a fabric to which is applied a dope finish, the same as on splits. The fabric is then embossed and when used on upholstery is difficult to tell from real leather.

A new process has just been invented for making imitation leather, in which cotton batting takes the place of the fabric. This cotton is worked into shape on a felting machine, and then with a suitable binder is pressed into sheets. These sheets are then given a dope finish and embossed. This process is of special interest as the cost of the finished product is less than the cost of the fabric used in the older process. The strength also is far greater than leather or the other imitation leather.

For a number of years we have known and used rubber soles. Recently, however, several sole-leather substitutes have been placed on the market under various trade names. These sole-leather substitutes depend upon rubber for the binding material, but differ from the rubber sole in that they contain loading material and fibrous matter. Although they do not wear as well as high-grade leather, they do have many points of value which should warrant consideration. Coming as they do when leather is short, they have served to tide us over a very serious situation and will continue to serve as a very timely and satisfactory adjunct to our sole-leather supply.

## Recent Metallurgical and Chemical Patents

**Fractionating Hydrocarbons.**—LEON E. HIRT of Los Angeles, Cal., patents an electric arc apparatus for fractionating hydrocarbon oils. In a copending application Serial No. 41,109, filed July 21, 1915, he has described and claimed a method and apparatus for this same general purpose, in which the oil to be fractionated is subjected to the action of an electric arc within a closed furnace or retort, in which a controllable pressure may be maintained. Hydrogen in some form or other suitable agent is present in the retort, the reaction between the hydrogen and the oil under the heat of the arc being present. The oil vapors thereby produced are conducted away and condensed. The present invention adds some further features to this general method. Referring to Fig. 1, the fractionation takes place in

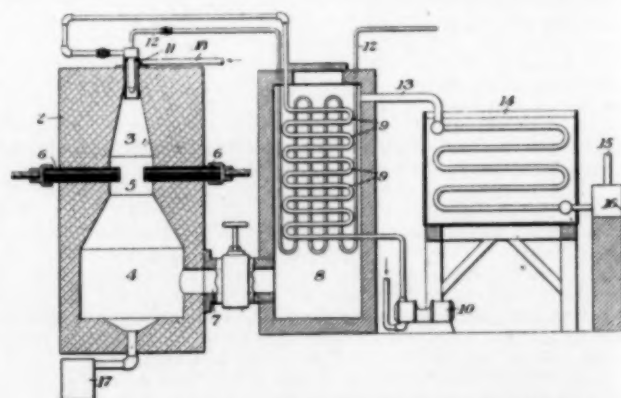


FIG. 1—DIAGRAM OF FRACTIONATING APPARATUS

the furnace or retort chambers designated 3, 4 and 5. Positive pressure of any desired degree can be created within said chamber by regulating the discharge of the vapors to the offtake 7, so as to hold them back within said chamber. In the form of apparatus shown, the ingoing oil is preheated in the chamber 8 to a high degree, since the temperature of the outgoing vapors will be high, depending upon the rate at which oil either atomized or as a vapor is fed. The outgoing temperature can thus be held between 600 and 1500 deg. Fahr., as may be desired. The oil will therefore be discharged into the furnace chamber largely in the form of a vapor and any unvaporized oil will be atomized by the action of the superheated steam passing through the nozzle.



The pump 10 will maintain the oil pressure to the desired intensity, and as the oil and steam pass the arc, the oil is partly broken up and fractionated. The steam introduced with the oil becomes more or less dissociated, the nascent  $H_2$  so formed entering into the reaction with the oils, and by causing the requisite pressure in the furnace chamber, any desired thermochemical compound of the oils can be formed. The  $O_2$  liberated combines with carbon to form  $CO$  gas. This is preferable to carbon in the free state, since the latter clogs up the furnace and discolors the condensed fractions. Free chlorine gas may also be introduced with the oil, or oil and steam, to unite with the carbon and form carbon tetrachloride. The latter can be recovered and used as a cleaning compound. Bromine gas may also be added either with or without steam. The halogen gas may be inserted through a pipe, such as indicated at 18. (1,250,879, Dec. 18, 1917.)

**Production of Sodium Hydroxide.**—CHARLES S. BRADLEY of New York City patents a process for the production of sodium hydroxides and allied products. The process is applicable as an adjunct to the ammonia-soda process. Ammonium chloride and barium carbonate are heated together to form ammonia, carbon dioxide, water and barium chloride. The ammonia, carbon dioxide and water are subjected to a higher temperature and pressure to form ammonium carbonate. This is then subjected to the action of sodium chloride to obtain sodium bicarbonate, regenerating the ammonium chloride. The bicarbonate is reduced to normal carbonate and causticized first with lime, filtered, then causticized with barium hydrate, regenerating barium carbonate for the first reaction with ammonium chloride. (1,249,314, Dec. 11, 1917.)

**Lactic Acid.**—SIGMOND SAXE of New York City patents a process for the manufacture of lactic acid from vegetable ivory, which is a very hard, ivory-like material used for making buttons and like purposes. Most of it comes from certain tropical American palms (*Phytelephas*, sp.). Waste material from button making and other manufacture can be obtained and used in the process. This is ground to 20 or 30 mesh and hydrolyzed by being boiled with 2 parts of 3 per cent sulphuric acid for six hours and cooled. It is then treated with calcium carbonate and filter pressed, and the liquid is then ready for fermentation. This is done with a lactic organism, capable of producing lactic acid. The fermentation may be conducted in the presence of a base adapted to form lactates, or the fermented mixture may be broken up with sulphuric acid equivalent to the calcium present. (1,249,511, Dec. 11, 1917.)

**Potash from Cement Dust.**—A process for increasing the solubility of potash in cement-kiln dust is patented by EVALD ANDERSON of Los Angeles (assigned to International Precipitation Co. of Los Angeles, Cal.). Under certain conditions, for example, when coal is used as fuel, causing presence of siliceous matter in the kiln gases, some of the volatilized potash combines with this siliceous matter, forming a difficultly soluble compound. The result is that with potash in this form present in the collected dust, this dust is not rated according to its full potash content as a fertilizer and the recovery of the potash in concentrated form by leaching and evaporation is impracticable, or uneconomical. The main object of the present process is to convert any such comparatively

insoluble material in the cement-kiln dust to a comparatively soluble form. This result is effected according to the present invention by subjecting the dust, containing the potash material partly in insoluble form, to the action of steam, preferably at a pressure in excess of atmospheric pressure.

The process is described as follows:

The cement-kiln dust is placed in a suitable container, steam is admitted and the potash containing material is subjected to the action of steam for sufficient time to convert most or all of the potash to water soluble form. In the case of a cement-kiln dust containing six per cent of potash in water soluble form and four per cent in water insoluble form, it was found that an exposure of the same steam at atmospheric pressure (100 deg. C.) is sufficient to convert all but one per cent of the potash to water soluble form. The same effect may be obtained in one hour by the exposure of the cement-kiln dust to steam at two hundred pounds pressure, the rapidity of the action increasing with the pressure and temperature of the steam. After treatment with the steam, the dust may be easily dried, since it absorbs a small percentage of moisture and it may then be used directly as a fertilizer, or it may, if desired, be leached by ordinary means for the purpose of obtaining the potash in a concentrated condition. (1,249,708, Dec. 11, 1917.)

**Outlet for Acid Concentrators.**—An outlet for acid receptacles is patented by JOEL J. DYE and WM. A. LUCAS of Newark, N. J., and assigned to the Butterworth-Judson Corporation of New York. The patentees state that most acid concentrators have outlets consisting of ordinary pipes with flanges, which are bolted to the wall of the concentrator with interposed gaskets. This method allows hot acid to run over the gaskets and the joints soon leak. The present outlet is designed to do away with this disadvantage. A cross-section of the outlet attached to a concentrator is shown in Fig. 2. The normal acid level is shown at the left.

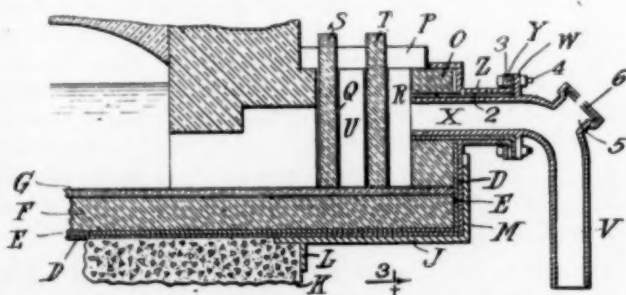


FIG. 2—VERTICAL SECTION OF OUTLET

The tank is constructed of a lead trough *D*, on which is an insulating or packing layer *E* and a course of brickwork *F*, finished with tiling *G*. This floor structure is extended as shown to carry the gates *S* and *T* and the outlet box, which consists of a block *O* of brickwork or other refractory material. A removable cover *P* rests on this block. This serves to prevent the escape of gas. The holes in the cover through which the gates *S* and *T* pass are sealed with sand or other packing material. The outlet pipe *V* is made of acid-proof iron with a flange *W*, located some distance beyond the inlet end of the pipe *X*, which extends into the wall as shown. The flange *W* is bolted to a flange *Y* on the end of a

tubular extension *Z* of the lead casing *D*. There is a seal of the liquid acid between the flame or hot air within the concentrator and the pipe and joints outside, and there is much less expansion of the parts of the joints by heat than where the pipe extends into the concentrator. The temperature of the air within the concentrator may, for example, be about 2000 or 2500 deg. Fahr. while the temperature of the acid is only about 700 deg. (1,249,728, Dec. 11, 1917.)

**Wood Distillation.**—Apparatus for wood distillation is patented by HARRY O. CHUTE of New York City, and assigned to K. P. McElroy of Washington, D. C. Wood or other vegetable material is destructively distilled in retorts under constant pressure, said pressure being controlled independently of the amount of incondensable gaseous products formed, the gases from the distillation are passed through a temperature-controlled channel to regulate its temperature, and then systematically washed and purified by a countercurrent of tarry or oily bodies, then freed of acetic acid by neutralization with a body of alkaline material maintained at a comparatively high temperature to form an acetate solution and thereafter treated to regain wood spirit. The wood spirit is subsequently purified. The apparatus comprises a retort, means for withdrawing effluent vapors and controlling the pressure, a temperature-regulating device receiving the effluent gases, means for distilling tar, means for systematically scrubbing the effluent gases with the distillate obtained, means for recovering the acetic acid from the purified gases in the form of a concentrated acetate solution, means for thereafter recovering wood spirit, means for purifying said wood spirit, and means for withdrawing incondensable gases, connected to the pressure controlling means. (1,250,282, Dec. 18, 1917.)

**Fused Ferric Sulphate.**—A process of producing fused ferric sulphate is patented by HERMAN B. KIPPER of Muskegon, Michigan. The raw materials used are sesqui-oxide of iron (iron ore) and niter-cake. The substances are mixed in theoretical proportions and are fused together in any suitable apparatus, at a temperature of 300 to 400 deg. C. If the process is carried out in a rotating drum or cylinder, producer gas is introduced and burned to furnish the heat. The following reaction takes place:  $\text{Fe}_2\text{O}_3 + 6\text{NaHSO}_4 = \text{Fe}_2(\text{SO}_4)_3 + 3\text{Na}_2\text{SO}_4 + 3\text{H}_2\text{O}$ . The ferric sulphate produced may be mixed with sodium chloride and made into ferric chloride. (1,250,471, Dec. 18, 1917.)

**Chlorine Derivatives of Toluol.**—The use of ultra-violet light in manufacturing chlorine derivatives of toluol is patented by HARRY D. GIBBS of San Francisco, Cal., and GEORGE A. GEIGER of Washington, D. C. The patent is dedicated to the public. They have found that when the toluol, converted into the gaseous state, is mixed with chlorine gas in definite proportions in the presence of ultra-violet rays, the desired products are produced in greatly increased yields over former processes, and without the production of unfavorable and interfering by-products. They recommend working without a catalyst. The process is especially applicable to the production of benzylchloride, benzolchloride and benzotrichloride. (1,246,739, Nov. 13, 1917.)

**Chlorine Substitution Products.**—A process for the production of chlorine derivatives of paraffin hydro-

carbons is patented by CHARLES BLANC of Akron, Ohio, and assigned to the Goodyear Tire & Rubber Company of Akron. A general description is as follows: Directly into a mass of the employed paraffin hydrocarbon, contained in some suitable reaction chamber, is conducted a stream of chlorine in some measure regulated to conform with the quantity of the hydrocarbon; to facilitate the reaction, particularly in the chlorination of the higher paraffin hydrocarbons, it is advisable to add to the hydrocarbons some halogen carrier. It is essential to this process that the reaction chamber be provided with some means for effectively cooling its contents, and simultaneously exposing said contents to the daylight, or sunlight, or any chemically active artificial light. The contents of the reaction chamber are removed either continuously or intermittently, and any unchanged paraffin hydrocarbon or any undesirable low-chlorinated derivatives of the employed paraffin hydrocarbon, separated from the desired chlorine derivative of the paraffin hydrocarbon by distilling, the unchanged paraffin hydrocarbon or undesirable lower-chlorinated derivatives of the paraffin hydrocarbon being returned to the reaction chamber where they are again submitted to the action of chlorine. The chlorinated paraffin hydrocarbon is removed from the still, washed with some aqueous alkaline solution, separated from the washing solution, and finally, if desired, dried and distilled. (1,248,065, Nov. 27, 1917.)

**Potash From Feldspar.**—A process for treating potassium-bearing silicate rocks for the recovery of potash is patented by JOHN S. BECKETT of Cranford, N. J., and one-half assigned to P. R. Moses of New York. The process as applied to orthoclase feldspar is as follows:

Orthoclase feldspar is furnaced with coke, limestone and calcium chloride in a copper blast furnace. The calcium chloride is used in sufficient amount to serve as the fluxing agent and to supply the necessary chlorine for forming potassium chloride. The amount of limestone can be varied within rather wide limits, but will in practice be used in such amounts as may be necessary or desirable for giving a melt of low fusion point or for furnishing a melt or sinter of a nature adapted for use for cement or for other purposes. The furnace product can also be thus made use of as a valuable by-product where it is desired to do so. During the furnace operation, the feldspar is decomposed and combines with the limestone and calcium chloride to form a complex silicate, while the chlorine of the calcium chloride combines with the potassium content of the feldspar to form potassium chloride, which escapes with the furnace gases. These highly heated furnace gases are then passed through a waste heat boiler and their heat energy thus recovered in the form of power. The waste gases are then passed through cyclone dust separators where considerable amounts of the potassium chloride are recovered in powder form; after which the waste gases pass to a scrubber in which the remaining potassium chloride is dissolved. The solution thus obtained can be concentrated to crystallization of the potassium chloride, which may then be separated centrifugally or otherwise or the solution can be used directly for the conversion of the potassium chloride into other potassium compounds. The residual melt is drawn off from the furnace to any suitable place of storage or use. When its composition is such that it



is available for use as cement material, it may be granulated by the action of water according to familiar methods. (1,247,619, Nov. 27, 1917.)

**Aluminium Alloy.**—An aluminium alloy for casting purposes is patented by WILLIAM A. MCADAMS of Bay Shore, N. Y. The ingredients are combined in the proportions of 100 parts by weight of aluminium, seventeen parts by weight of copper, five parts by weight of zinc, one and one-half parts by weight of antimony, and one part by weight of silver. In making the alloy, the antimony is melted in about one quarter of the aluminium at a high heat. The copper is then added and then the silver is added. The heat of the mass is then lowered and the balance of the aluminium is added. The mass is agitated thoroughly and the temperature still further lowered to a dull red and then the zinc is added. The mass is still thoroughly agitated and the scum removed, and the mass may then be cast into ingots. (1,247,977, Nov. 27, 1917.)

### Developments in Filtration

AT A MEETING of the New York Section of the Society of Chemical Industry, Oct. 19, 1917, Mr. WALTER L. JORDAN of the Celite Products Company of New York described some very interesting problems in filtration, with particular reference to the use of Filter-Cel as a filter aid.

He divided filtration problems into three classes as follows:

1. Those in which the suspended solids are rigid and either crystalline or amorphous.
2. Those in which the suspended solids are non-rigid bodies, i.e., those approaching the colloidal, although the individual particles may be far greater in size than those properly classed as such.
3. Suspensions containing mixtures of the above classes.

Problems of the first class are the easiest to handle, as it is merely necessary to choose a proper filtering medium, either cloth or screen.

In a few instances precipitates of the second class can be converted into the crystalloidal state either by proper regulation of the precipitation or by subsequent treatment. This should be done wherever possible and thus convert the problem into one under the first class.

Those non-rigid suspended solids which do not lend themselves to crystallization and which have many of the properties and characteristics of colloids (although they may be much larger in size) constitute the most difficult problems in filtration. When one contemplates the difficulties the chemical engineer has to contend with in handling these problems on the large scale, it is easy to understand the aversion to making such separations by filtration and it accounts for the endless attempts that have been made to solve such problems by other means.

Often a problem is rendered more complex by the viscosity of the liquid as in the case of concentrated syrups. In the past gravity filtration has been depended on in coping with this type of problem.

Problems in the third class vary from those in which the rigid particles predominate to those in which practically all the suspended solids are non-rigid.

An example of the third class of problem in which rigid particles predominate is the calcium carbonate

precipitate obtained by the carbonation of beet sugar diffusion juice. The precipitated lime carries down albuminous and pectinous bodies through the coagulating effect of liming, heating and carbonating, probably also by adsorption. This precipitate filters readily providing precautions have been taken to bring the calcium carbonate down in a crystalline condition. However, juices from decayed beets offer grave difficulties, because the juices are much higher in organic impurities and especially those of a gelatinous nature, and the normal quantities of lime are not sufficient to render this cake filtrable. Several years ago over 100,000 tons of sugar beets were lost in one State as a result of this condition. The author stated that had supplies of Filter-Cel been available, it would have been possible to have worked these beets up and recovered the sugar.

These two instances in beet sugar carbonation work illustrate the two possible extremes under this class of problem. First the normal beet juice, limed and carbonated, yields a suspension of solids that is readily filtered. In the case of juice from decayed beets the larger percentage of non-rigid solids may make filtration impossible unless much larger quantities of lime or some other filter aid can be incorporated in the cake. The factories burn their own lime and are therefore limited to their normal production of it.

It is always an advantage to coagulate the non-rigid solids as thoroughly as possible. If the impurities are largely albuminous, heat will compact the particles and reduce the volume that they will occupy between the rigid particles present, and the continuity of the pores of the cake will be more nearly maintained. If the coagulation is carried out in the presence of the rigid bodies, the non-rigid will become firmly attached and prevented from being forced through the cake toward the retaining medium.

Some of the diverse problems that have been solved by the application of Filter-Cel as an aid in filtration are as follows:

**Vegetable Oils.** One of the most interesting applications is in the filtration of linseed oil. This oil is ordinarily filtered warm just as it comes from the hydraulic press. The warm filtered oil on cooling and standing deposits some of the solid fats. By cooling before filtration this after-deposition can be prevented. The addition of about 0.2 per cent of Filter-Cel makes it possible to filter the raw oil at temperatures of 35-40 deg. Fahr. It is probable that a similar procedure would be advantageous in the case of cottonseed and peanut oils, where it is desirable to have an oil of the utmost brilliancy.

**Varnishes.** Varnishes can be clarified perfectly by filtration in a pressure filter. Usually a thin film of Filter-Cel is first deposited on the cloths from a suspension in clear varnish. The initial film protects the cloths. This is then followed by the cloudy varnish having an additional admixture of  $\frac{1}{2}$  to 1 per cent of Filter-Cel.

**Lubricating Oils.** Used automobile and gas engine lubricating oils contain carbon in a very finely divided state. This carbon has been removed by a Filter-Cel filtration followed by a distillation to remove water, gasoline, etc. It is claimed the revived oil is superior to the original.

A recent application of Filter-Cel was in the filtra-

tion of wine in a pressure filter. Formerly it was necessary to clarify by means of coagulents such as gelatine, albumen, etc. The process of pressure filtration shortens the time and gives perfect clarification.

Perhaps the most important change in the process of sugar refining in recent years, the author stated, is the adoption of pressure filters of the leaf type in place of the bag filter. This change in method of filtration is made possible by the elimination of the defecation with lime and phosphoric acid. Instead of this a suitable quantity of Filter-Cel is agitated with the liquor just prior to filtration.

Occasionally problems are encountered in which it is not permissible to mix a foreign substance with the precipitate. In such cases, however, it is possible to remove the filter aid in some later process as in the recovery of paraffin by chilling. After the oil has been purged from the paraffin, the latter can be warmed and separated from the Filter-Cel.

The author believes that the use of filtration aids will develop greatly, especially in connection with the more extended use of metallic cloth and screen. Further development will be through the use of higher pressures, thus giving an increased capacity to filtration apparatus.

### Flexible Means of Heating Small Space in Industrial Works

The steel-jacketed electric heater-unit shown in the accompanying illustrations has been put to innumerable uses in all kinds of industrial plants. Besides such applications as in crane cabs, valve, pump and meter-



SHOWING AN APPLICATION OF THE C-H SPACE HEATER UNIT IN A METER HOUSE

houses, there have been scores of miscellaneous applications. The ease of conducting electric current to remote corners makes the use of electric heat simpler than any other. The heater-units shown are of 500 watts capacity, and can be connected up in multiple to any a.c. or d.c. circuit where the voltage is not in excess of 250 volts. Only as many as are actually required need be installed, yet additions can be made easily as adding electric lamps. Just as lamps are placed singly or in groups in locations when light is required, so also are these units mounted singly or in groups in locations where heat is required.

The units are flat like an ordinary meter, the dimensions being 3/18 in. by 1 1/2 in. by 23 3/4 in. All parts are enclosed and no porcelain, cement, asbestos or moulded insulation material used. Insulated eyelet holes permit the use of ordinary screws for mounting. Terminal connectors are placed at each end. In mount-



SHOWING CARTON IN WHICH C-H SPACE HEATER UNITS ARE PACKED (10 IN A CARTON)

ing, space is provided between units and between unit and surface on which it is mounted to allow for a good circulation of air. The installation view shows one of these C-H units installed in the gas-valve house in a coke plant. These units are designed and manufactured at the New York works of The Cutler-Hammer Manufacturing Company of Milwaukee.

### Floating Agitator for Gas Producers

A NEW development in the gas producer line is being placed on the market by the Chapman Engineering Company of Mt. Vernon, Ohio. Fig. 1 illustrates the construction of this machine. The agitator is in the form of an inverted tee, made of double extra-heavy seamless tubing. It revolves through the surface of the fire-bed at the rate of five revolutions per hour, or more if desired. The cross-arms of the tee are provided with stirring fingers made of high-carbon steel. An inner tube carries cooling water to the end of each finger.

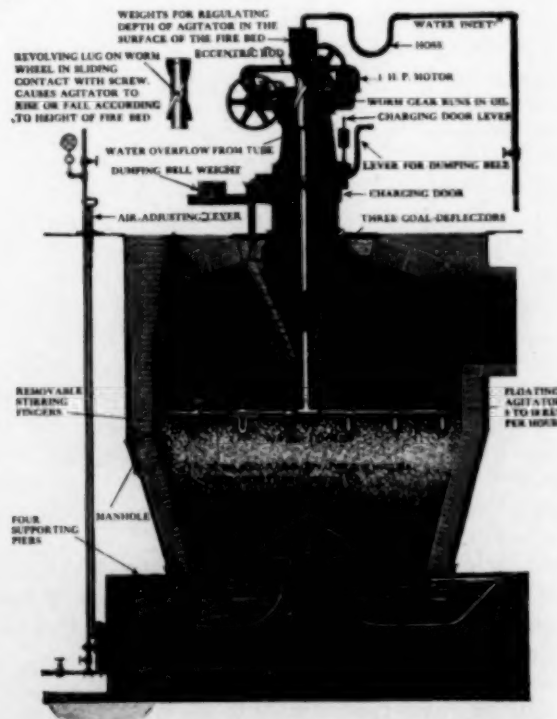


FIG. 1—INTERIOR VIEW OF GAS PRODUCER WITH FLOATING AGITATOR



The important feature of this agitator is that it automatically accommodates itself to the varying height of the fire-bed. This raising and lowering is accomplished by a special driving-head provided with two large screw-like spiral flanges. These flanges engage in sliding contact with two lugs projecting inwardly from the hub of the driving wheel. Normally the driving wheel and driving-head revolve together, but should the agitator strike an obstruction, or become submerged too deeply in the fire-bed, it automatically "screws up" at once to a point where the forces are again in balance.

If an excessively high fire-bed ever caused the agitator to "float" up to its extreme limit (2 ft.), it would automatically release, thus relieving all strain upon the machinery. The mechanism is driven by a 1 hp. inclosed-type motor.

The agitator is not designed to break up clinkers after they are formed, but to prevent their formation by destroying the blow-holes and hot-spots, which are the primary cause both of clinkers and of poor gas. It is claimed that the frequent stirring of the entire surface of the fire-bed greatly increases the capacity, and improves the quality and uniformity of the gas. Practically all hand-poking is said to be eliminated.

It is stated that the machines can easily be applied to any type of stationary producer already in use. Its makers guarantee that it will increase the capacity 75 per cent, reduce the hand-poking 75 per cent, and maintain a richer and more uniform quality of gas.

The following three analyses represent the average gas made by the agitators in three different steel works. No hand-poking was required, and no objectionable clinkers were made.

	Pittsburgh Gas Coal		Indiana Deep
	Rate per hr. lb.		Vein Coal
	1995	1600	1400
CO <sub>2</sub> .....	5.2	5.0	6.6
H <sub>2</sub> .....	0.1	0.8	.02
O <sub>2</sub> .....	0.1	0.4	0.0
CO .....	24.1	24.6	19.2
CH <sub>4</sub> .....	2.7	3.5	3.8
H <sub>2</sub> .....	14.0	11.5	13.6
N <sub>2</sub> .....	53.9	54.2	56.6
B. T. U. ....	143.3	151.0	137.5

These agitators are made in two different forms. First, as a part of a complete producer. Second, separately from the producer proper, to be installed on old style hand-poked uroducers already in use. The agitator is built with or without an automatic coal feeder, as required by local plant conditions.

### A New Insulating Material

An insulating material which is said to be fireproof, waterproof, acid proof and electric current proof, composed of chemically treated pulverized waste material which may be molded, stamped or pressed into all special or commercial sizes and shapes, has been developed by Harry A. Dorr and will be made by the Dorr-rite Insulation Company, 188 Culver Avenue, Jersey City, N. J., after Feb. 1, 1918.

A piece of this insulating material, 3 in. (7.6 cm.) in diameter,  $\frac{1}{8}$  in. (3.2 mm.) thick, was immersed in water for 70 hours, then subjected to 40,000 volts, and no marks, change in weight or leakage appeared; the same piece was boiled for one hour in cutting oil at 650 deg. Fahr. and stood the same test. A piece 6 in. (15.2 cm.) square and  $\frac{1}{8}$  in. (3.2 mm.) thick stood a test of 88,000 volts in oil without leakage or breakdown.

## Personal

Mr. ROBERT J. ANDERSON has resigned his position as chief chemist and metallurgist of the Cleveland Metal Products Co., Cleveland, Ohio, to take effect Feb. 1, 1918.

Mr. C. P. COLEMAN was elected president of the Worthington Pump & Machinery Corporation at a meeting of the board of directors on Dec. 31.

Mr. A. L. FEILD, assistant metallurgist at the Lake Superior station of the U. S. Bureau of Mines, has resigned to enter private employment and is succeeded by P. H. Royster, who has been connected with the iron and steel investigation of the bureau for several years.

Dr. CHARLES L. REESE, Wilmington, Del., was formally elected presiding officer of the Philadelphia, Pa., section of the American Chemical Society at a recent meeting, to serve in that capacity until December, 1918.

Mr. FOREST RUTHERFORD, until recently metallurgist and general superintendent of reduction works for the Copper Queen Consolidated Mining Co. (Phelps-Dodge Corporation) at Douglas, Ariz., is now engaged in consulting metallurgical engineering and has an office at 120 Broadway, New York City.

Dr. CHARLES E. VANDERKLEED, formerly connected with the H. K. Mulford Company, Philadelphia, Pa., has become associated with the Markleed Chemical Company, recently incorporated in New York with a capital of \$220,000, and which has acquired the plant of the Waverly Chemical Company at Camden, N. J., now engaging in the manufacture of phenolphthalein, acetyl, salicylic acid, and other synthetics.

Mr. C. H. VOM BAUR, well known in the electric steel industry, and formerly with Hamilton & Hansell and other concerns, has opened an office at 30 Church St., New York, where he will engage in consulting work and introduce a furnace of his own design.

Mr. A. P. WATT has opened offices in New York City as metallurgist, where he will specialize on the concentration of ores and the treatment of industrial wastes. His offices are at 52 Vanderbilt Avenue, Room 1903.

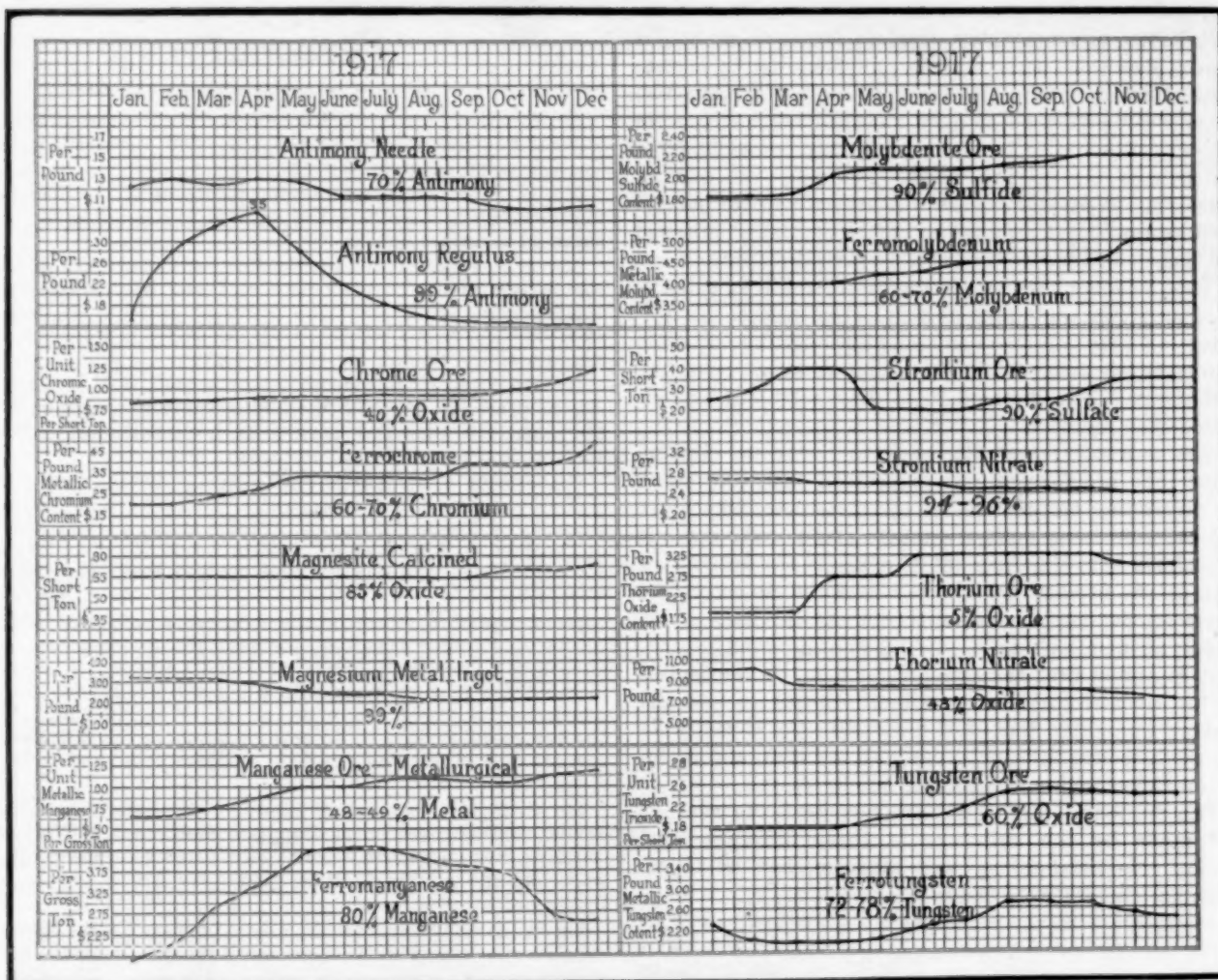
Mr. A. E. WHEELER, consulting engineer for the Union Miniere du Haut Katanga, has recently gone to their head office in London to submit alternative plans for the metallurgical treatment of a large body of oxidized ore occurring on their concession in the Belgian Congo near Elizabethville.

Mr. BRUCE C. YATES, assistant superintendent and chief engineer of the Homestake Mining Co., Lead, S. D., has been appointed superintendent to succeed RICHARD BLACKSTONE, who retired on Jan. 1, 1918. Mr. Yates is a graduate of the University of Nebraska and has been with the Homestake company for the last 20 years.

## Obituary

Mr. SILAS W. ECCLES, vice-president of the American Smelting & Refining Co., passed away at St. Augustine, Fla., on Dec. 31, 1917. Mr. Eccles was also president of the Alaska Steamship Co. and president of the Copper River & Northwestern Railroad. He was born in Washington, Ill., Jan. 3, 1852, and commenced his career in business as a station agent and telegraph operator for the Chicago & Alton Railroad. In 1876 he went to the Denver & Rio Grande Railroad and a year later was appointed general passenger agent of the system.

Prior to becoming connected with the American Smelting & Refining Co. Mr. Eccles was traffic manager of the Oregon Short Line Railroad. In 1900 he became identified with the smelting and refining business, and became a director of the American Smelting & Refining Co. He was also president of the Nevada Northern Railroad and an officer and director of other corporations.



### Prices of Some Less Common Products in 1917

The accompanying chart, for which we are indebted to the Foote Mineral Company of Philadelphia, shows the variation in prices in 1917 of several interesting products, including ores, ferroalloys, etc. In addition we include below data on several products also furnished by courtesy of the above company.

**Bismuth.**—The price remained fairly steady at \$3.25 per lb. during the first half of the year. During the last quarter of the present year prices declined still further, due to importations of crude bismuth metal from South America by independents. The present quotations for pure metal range according to quality from \$2.65 to \$3.00 per pound. The activities of independent South American producers of crude metallic bismuth indicate still further recessions in price for the coming year.

**Cerium.**—Cerium products remained firm during the year. The two most important products are metallic cerium and cerium oxalate. Ferrocium was steady at \$25.00 per lb. for large contracts. Production is believed to be several thousand pounds per month, and is in the hands of practically only one manufacturer owing to foreign patents.

**Palladium.**—Owing to the large demand from manufacturers of platinum substitutes the price advanced from \$115 in the spring to \$125 in the summer and higher figures are now being paid. The bulk of the production is sold far ahead.

**Selenium.**—Remained firm at \$1.20 per lb. during first half of year. During last half an increased demand from the glass trade sent it up to \$2.60 to \$3.25.

**Uranium.**—Price remained firm at \$50.00 to \$60.00 per unit per ton for ore carrying 2 per cent  $U_3O_8$ . Black

uranium oxide remained firm at \$3.25 per lb., 96 per cent  $U_3O_8$ .

**Vanadium.**—Ferrovanadium ranged from \$2.75 to \$3.00 per lb. of metal contained for 30 to 35 per cent material. During the last quarter this price advanced to as high as \$7.50, owing to large Government demands.

## Current Market Reports

### The Iron and Steel Market

Announcement on behalf of the President, Dec. 28, that iron and steel prices as set would be continued to March 31, has not resulted in any change in the general situation as to activity. The market remains very dull all along the line, a reflection doubtless of general conditions. There is still a large volume of contract business to be carried out, and under present conditions, with prices set, with Government priority being given on a great deal of material, and with the rate of production uncertain, the natural tendency is not to buy for deliveries far ahead. A part of the dullness of the past few weeks is doubtless to be attributed to the year-end adjustments, taking of inventory, making up tax estimates, etc., all particularly complicated this year, and having to be accomplished with reduced office forces, so that the usual tendency of the iron and steel market to be dull at this season is naturally accentuated.

#### PRICE REVISION LATER

The trade, both sellers and buyers, seems to have tacitly assumed that the proviso in the Washington announcement, that contracts made involving delivery after March 31 must carry a clause providing for readjustment of prices against any prices that may be set later by a Government agency, means that probably prices will be re-



duced by March 31 or shortly thereafter. The only question is whether the Washington authorities are looking forward to a voluntary agreement by the iron and steel producers for lower prices, or are depending upon prospects that the Pomerene iron and steel price fixing bill will be enacted. It is understood that the bill is to have precedence over nearly everything else in the two houses.

The contention that the present set prices are necessary by reason of the cost of production has not been particularly successful. The costs of some producers are extremely high, but they represent only a small percentage of the total production, and in many cases high costs are directly traceable to there being contracts for raw materials at higher than the set prices or to irregular operation due to congested traffic conditions. The Federal Trade Commission desires to correct the first drawback to economical production by having Congress give the Executive the authority to cancel such contracts, while the latter difficulty is to be corrected by producing better transportation conditions. That would be a small thing for Government operation of the railroads to accomplish, for the total amount of transportation the iron and steel industry has lacked, between its recent rate of operation and operation at capacity, is only a fraction of 1 per cent of the total freight moving facilities of the country, measured in ton-miles.

#### PIG IRON PRODUCTION

For several weeks the blast furnaces tributary to the Connellsville coke region have operated at an average of 80 to 90 per cent of capacity in the case of the merchant stacks and at 70 to 85 per cent in the case of the steel works furnaces. Shipments of Connellsville coke have averaged barely 300,000 net tons a week, against 350,000 tons a week during the first nine or ten months of 1917 and 421,000 tons a week in 1916. The furnaces do not need as much of this coke as in 1916, by reason of many by-product ovens having since been completed. The coke region maintains it could have shipped much more coke if transportation had been available. So far as can be seen, if transportation were provided 75,000 tons more coke per week could be furnished, and that would mean, say, 75,000 tons more pig iron a week. With intermittent operation through frequent banking, and through coke being held in ovens over 72 hours waiting cars and getting overburned, the average coke consumption at many blast furnaces has risen by hundreds of pounds per ton of iron. Now 75,000 tons more pig iron would mean correspondingly more steel and the market might take on quite a different aspect if there were this increased production, for there is no evidence that consumers generally have been greatly incommode by the reduced deliveries of the past few weeks. The increased output of iron and steel might prove quite formidable, whereas the additional transportation required is inconsequential. The 75,000 tons of coke a week would represent roughly about 10,000,000 ton-miles of freight per week, and last summer at any rate the railroads of the United States were producing more than 8,000,000,000 ton-miles of freight movement per week. Thus one-eighth of 1 per cent more transportation applied to the iron and steel industry would probably produce a very striking alteration in the relation between demand and supply.

#### CONTRACTS IN FORCE

The finished steel industry is operating largely on old contracts. In bar, shapes and plates the deliveries, apart from those on Government orders, are chiefly against contracts made prior to last May, since which time there has been little buying of these products except for early deliveries, or against Government requirements. In pipe, wire products and sheets the deliveries are more against sales made lately for shorter periods. The interest of the mills at this time is chiefly in converting the present contract obligations into definite orders and shipments. In most cases there is no definite sales policy, the idea being that that is a matter for the future, and the market is really drifting. In a few weeks more, particularly if transportation conditions improve, the future of the steel market, as to prices and demand, should have at least a little light thrown upon it.

#### WAR REQUIREMENTS

There is much confusion of thought as to the war requirements in steel, this being caused by the natural tendency to ascribe nearly all steel consumption to war requirements, as nearly all the consuming industries are more or less helpful in prosecuting the war. This is theoretically a correct viewpoint, but practically it settles nothing, for it is not the production of steel but the use of steel that helps to win the war, and these consuming industries have their limitations, which, of course, are purely physical. Those who use steel as a result of being given Government orders, as munition manufacturers, shipbuilders and the like, are in one category; those who use steel to produce oil, coal, farm implements and the like are in another category. To the former price may be no object. To the latter it is an object.

There are certainly possibilities of steel in many forms becoming decidedly more plentiful and indeed of having occasion to seek its market. Leadership in point of scarcity has for nearly two years been given to plates, yet the market in the past fortnight has disclosed rather free offerings of plates, of certain specifications, by half a dozen or more mills, and when that occurs in plates there is room for much inference as to what may occur in the next few months as to steel products generally.

#### Non-Ferrous Metal Market

**Monday, Jan. 7.**—The tin market is dull and prices are considerably lower, in spite of the great scarcity of supplies. Nothing of special interest has happened in the copper and zinc markets. Lead has been advanced by the Trust.

**Copper.**—The prices remain at 23.50 for producers and 24.67½ for jobbers as fixed by the Government. There is apparently enough copper available for all purposes at present, but considerable concern is felt over the coal and railroad situation. In London standard is quoted at £110 and electrolytic at £125. The demand for copper in munitions making is expected to increase rapidly.

**Tin.**—The situation is no better and were it not for the fact that there seems to be but little consuming demand a very serious situation would be the result. Two weeks ago Straits tin sold up to 85 cents, but it has now declined to a nominal quotation of 67 cents, following a sensational decline in the London market from £302¼ to £269. The London market has recovered, however, and spot Straits is quoted now at £281. Total deliveries in December were 4683 tons, with stocks on hand at the end of December of only about 500 tons. Spot tin of any kind is hard to obtain at present. Future Chinese No. 1 is quoted at 62.00 cents.

**Lead.**—The trust price of lead was advanced on Jan. 3 to 6.50 cents New York basis. The outside price is 6.75 to 7.00 cents. Following a dull period, a large demand has sprung up from consumers. Government purchases have been settled on the average St. Louis prices, while New York prices were lower.

**Spelter.**—This market continues dull, with a slightly better demand for Grades A and B for Government work. Grade B is now 10.25 cents. Prime Western is held at 7.75 cents.

**Antimony.**—The antimony market continues dull, with 14.50 cents quoted.

**Tungsten.**—Tungsten ore remains at \$24.00 for high-grade wolframite and \$26.00 for scheelite. It is difficult to move material on account of the railroad congestion.

**Molybdenite.**—Price remains at \$2.25 to \$2.30 per lb., with a fair demand.

**Quicksilver.**—Supplies are scarce and the market has advanced to \$130-\$135 per flask for California material.

#### OTHER METALS

Aluminum, lb.	36-38
Bismuth, lb.	3.00-3.50
Cadmium, lb.	1.50
Nickel, electrolytic, lb.	.55
Silver, oz.	.89%
Platinum, oz.	105.00
Palladium, oz.	130.00-135.00

### Chemical Market

**Coal Tar Products.**—Conditions in this market have been quiet of late. The requisitioning by the government of several of the important items has tended to a certain extent to restrict operations. The scarcity of material has also contributed toward the conditions obtaining.

**Benzol.**—Offerings are liberally made, but the buying demand is much below normal. Consumers of large quantities who ordinarily cover for the year on contract are backward about doing so and low prices therefore hold sway.

**Phenol.**—Governmental requirements are receiving first consideration and offerings are light, with a slight advance in price.

**Naphthalene.**—Not much interest is displayed by either buyers or sellers at present, spot material is scarce and forward positions are fractionally advanced in price.

**Toluol.**—The government has seized practically the whole production, and there is none obtainable on the open market. A few drums pass now and then at fancy figures.

**Aniline Oil.**—A slightly improved demand, together with a scarcity of the necessary acids, has caused a firmer position and a slight advance in price.

**Salicylic Acid.**—The production of late has been heavy and a few factors in the market were absorbing the output until recently, when their requirements were filled, with the result that prices have declined.

**Beta Naphthol.**—Was in better demand and spot stocks of the technical grade are in light supply, but prices thus far are unchanged. The sublimed material is in better supply and the demand is light.

**Dinitrophenol.**—Offerings are liberal with the demand light and prices unchanged.

**Para-amidophenol.**—A heavy production with a falling off in the demand has caused prices to decline.

**Ortho-Toluidine.**—The toluol situation has caused a scarcity of this material, and only a few dealers are quoting, with prices slightly higher.

**Para Toluidine.**—Is in better supply, although there are only a few dealers offering, with prices unchanged.

**Anthracene.**—Is practically off the market, several inquiries having failed to locate material quantities.

**HEAVY CHEMICALS.**—The movement in chemicals during the past two weeks has been of a minor character and prices, as is usual toward the close of the year, have shown a tendency to ease off. There is reported to have been more inquiries coming in during the first week of the new year, and this is generally taken as an indication of activity soon to develop.

**Caustic Soda.**—There has been no real buying for consuming accounts since our last report. The short interest which has developed during the period since Oct. 1 is reporting much difficulty in having bills of lading accepted and these bills are being rejected on the slightest technicality. As a consequence there has been a decided speculative interest shown in certain positions such as December bills of lading for 25-ton cars. Buyers have been willing to pay concessions to cover in exact conformity with contracts to avoid disputes. Spot positions have receded to 6.40 and 6.50. Over the year quotations vary from 6.35 to 6.60, according to seller. The usual probability of non-delivery attaches to the low quotations.

**Soda Ash.**—Owing to the lack of export licenses, bags have firmed up and are scarce, while barrels are more plentiful and easier. The movement has been entirely speculative, however. December bills of 25-ton cars have been mostly in demand to fill in contracts. These commanded 3.05 to 3.10 as we write, while barrels in contrast were available at 3c. to 3.05c. From the works bags were obtainable at 2.90c. to 3c.; barrels at 3c. to 3.05c.

**Acids.**—As there is seemingly no sulphuric acid other than the 66-degree concentration and but limited trading in that, there is little that can be stated regarding the market. Sixty-six degree brimstone acid has sold at \$75 to \$80, drums included, with a few spot offerings from time to time at \$43, drums extra. Oleum has sold at \$65 and \$75, and \$80 is now asked. Muriatic acid as a result of government buying has become so scarce that the 18-degree material is now practically the only test available and sellers

are asking 4c. for June-December delivery. Nitric acid has not been so active, and 42-degree material is available at 9c. to 10c. Phosphoric acid has eased off owing to the lack of demand and the 48/52 per cent is now available at 7c. to 7½c.

**Chlorate of Potash.**—Manufacturers established the price of 40c. shortly before the new year covering 1918 business and shortly announced that in some instances this price had been advanced to 42½c. However, the outside market has not responded and sales of December chlorate were closed the first week of the year at 39c. It will be recalled that all during 1917 the outside market was lower than the contract price.

**Bichromates.**—Spot soda and potash has been somewhat firmer. This is principally due to the railroad situation. For soda the 1918 price is 16½ to 17c., but the contracts contain so many war clauses that the buyer really does not know how much he will pay for the product before he consumes it.

### General Chemicals

WHOLESALE PRICES IN NEW YORK MARKET, JAN. 7, 1918

Acetic anhydride.....lb.	1.80	1.90
Acetone, drums.....lb.	Nominal	
Acid, acetic, 28 per cent.....lb.	.05½	.06
Acetic, 56 per cent.....lb.	.11½	.12
Acetic, glacial, 90½ per cent, carboys.....lb.	.34	.35
Boric, crystals.....lb.	.13½	.14½
Citric, crystals.....lb.	.75	.78
Hydrochloric, C.P.....lb.	Nominal	
Hydrochloric, 20 deg.....lb.	Nominal	
Hydrochloric, conc., 22 deg.....lb.	Nominal	
Hydrofluoric, 30 per cent, in barrels.....lb.	.06½	.06½
Lactic, 44 per cent.....lb.	.15	.15½
Lactic, 22 per cent.....lb.	.05½	.06½
Nitric, 36 deg.....lb.	.09	.10
Nitric, 42 deg.....lb.	.09	.10
Oxalic, crystals.....lb.	1.45	.46
Phosphoric, 47 per cent-50 per cent.....lb.	.07	.07½
Picric.....lb.	Nominal	
Pyrosulphuric, resublimed.....lb.	3.15	3.25
Sulphuric, 60 deg.....ton	42.00	44.00
Sulphuric, 66 deg.....ton	70.00	80.00
Sulphuric, oleum (Fuming), tank cars.....ton	1.30	1.35
Tannic, U. S. P., bulk.....lb.	.78	.80
Tartaric, crystals.....lb.	1.80	1.90
Tungstic, per lb. of W.....lb.	5.05	5.25
Alcohol, sugar cane, 188 proof.....gal.	Nominal	
Alcohol, wood, 95 per cent.....gal.	.78	.80
Alcohol, denatured, 180 proof.....gal.	.04½	.05
Alum, ammonia lump.....lb.	.18	.19
Alum, chrome ammonium.....lb.	.23	.25
Alum, chrome potassium.....lb.	.12½	.13
Alum, chrome sodium.....lb.	Nominal	
Alum, potash lump.....lb.	.02½	.02½
Aluminium sulphate, technical.....lb.	.02½	.03
Aluminium sulphate, iron free.....lb.	.19½	.20
Ammonia aqua, 26 deg. carboys.....lb.	.11	.12
Ammonium carbonate.....lb.	(Fixed price)	.14
Ammonium nitrate.....lb.	.07½	.07½
Ammonium sulphate domestic.....lb.	5.25	5.40
Amyl acetate.....gal.	.15	.16
Arsenic, white.....lb.	.65	.70
Arsenic, red.....lb.	80.00	90.00
Barium carbonate, 99 per cent.....ton	65.00	67.00
Barium carbonate, 97-98 per cent.....ton	70.00	90.00
Barium chloride.....lb.	.03½	.04
Barium sulphate (Blanc Fixe, powder).....lb.	.09½	.11
Barium nitrate.....lb.	.32	.38
Barium peroxide, basis 70 per cent.....lb.	.02½	.02½
Bleaching powder, 35 per cent chlorine.....lb.	.07½	.08½
Borax, crystals, sacks.....lb.	Nominal	
Brimstone, crude.....lb.	.65	.70
Bromine, technical.....lb.	Nominal	
Calcium, acetate, crude.....lb.	.08½	.11
Calcium, carbide.....lb.	21.00	25.00
Calcium chloride, 70-75 per cent, fused, lump.....ton	1.60	1.70
Calcium peroxide.....lb.	.30	.31
Calcium phosphate.....lb.	.07	.07½
Calcium sulphate.....lb.	.14	.16
Carbon bisulphide.....lb.	.82½	
Carbon tetrachloride, drums.....lb.	.06½	.06½
Caustic potash, 88-92 per cent.....lb.	.15	.18
Caustic soda, 76 per cent.....lb.	.15	.18
Chlorine, liquid.....lb.	1.40	1.50
Cobalt oxide.....lb.	.01½	.01½
Coppersas.....lb.	.45	
Copper carbonate.....lb.	.75	.78
Copper cyanide.....lb.	.09	.09½
Copper sulphate, 99 per cent, large crystals.....lb.	.61	.63
Cream of tartar, crystals.....lb.	.03½	.04
Epsom salt, bags.....lb.	.19½	.20
Formaldehyde, 40 per cent.....lb.	1.00	1.10
Glauber's salt.....100 lb.	.67½	.70
Glycerine, bulk, C. P.....lb.	4.25	4.35
Iodine, resublimed.....lb.	.13	.15
Iron oxide.....lb.	.17	.17½
Lead, acetate, white crystals.....lb.	.15	.18
Lead arsenate (Paste).....lb.	Nominal	
Lead nitrate.....lb.	.09½	.11½
Litharge, American.....lb.	1.50	2.00
Lithium carbonate.....lb.	.70	.75
Manganese dioxide, U. S. P.....lb.	.10	.10½
Magnesium carbonate, tech.....lb.	Nominal	
Nickel salt, single.....lb.	Nominal	
Nickel salt, double.....lb.	1.70	
Phosphorus, red.....lb.	1.25	
Phosphorus, yellow.....lb.	.45	.46
Potassium bichromate.....lb.	1.45	1.50
Potassium bromide granular.....lb.		



Potassium carbonate calcined, 85-90 per cent.	lb.	.60	—	.65
Potassium chlorate, crystals	lb.	.40	—	.42½
Potassium cyanide, 98-99 per cent.	lb.	Nominal		
Potassium iodide	lb.	3.75	—	3.80
Potassium murate 80-85 p.c. basis of 80 p.c.	ton	350.00	—	
Potassium nitrate	lb.	.30	—	.32
Potassium permanganate (U.S.P.)	lb.	.80	—	.85
Potassium prussiate, red	lb.	2.60	—	2.70
Potassium prussiate, yellow	lb.	1.25	—	1.35
Potassium sulphate, 90-95 p.c. basis 90 p.c.	ton	Nominal		
Rochelle salts	lb.	.39	—	.39½
Salammoniac, gray gran.	lb.	.15	—	.16
Salammoniac, white gran.	lb.	.16	—	.17
Salt soda	100 lb.	1.25	—	1.30
Salt cake	100 lb.	1.50	—	2.00
Silver cyanide, based on market price of silver	oz.	.53	—	.55
Silver nitrate	oz.	2.90	—	3.05
Soda ash, 58 per cent. light, flat	100 lb.	3.50	—	4.00
Soda ash, 58 per cent. dense, flat	100 lb.	1.6½	—	1.7
Sodium acetate	lb.	3.75	—	3.85
Sodium benzoate	lb.	.02½	—	.03
Sodium bicarbonate, domestic	lb.	.17½	—	.18
Sodium bicarbonate, English	lb.	.06½	—	.06½
Sodium bisulphite, powd.	lb.	.20	—	.22
Sodium chloride	lb.	.42	—	.44
Sodium cyanide	lb.	.18½	—	.19
Sodium fluoride, commercial	lb.	.02	—	.02½
Sodium hyposulphite	lb.	2.50	—	3.70
Sodium molybdate, per lb. of Mo	100 lb.	3.60	—	3.70
Sodium nitrate, 95%	lb.	.30	—	.35
Sodium nitrite	lb.	.45	—	.48
Sodium peroxide	lb.	.04	—	.04½
Sodium phosphate	lb.	.36	—	.37
Sodium prussiate, yellow	lb.	4.00	—	4.50
Sodium silicate, liquid. (60 deg.)	100 lb.	.02½	—	.03
Sodium sulphide, 30 per cent crystals	lb.	.04½	—	.05
Sodium sulphide, 60 per cent, fused	lb.	.05	—	.06
Sodium sulphite	lb.	.25	—	.35
Strontium nitrate	lb.	.06	—	.06½
Sulphur chloride, drums	lb.	.15	—	.40
Sulphur dioxide, liquid, in cylinders	100 lb.	4.05	—	4.10
Sulphur, flowers, sublimed	100 lb.	3.70	—	3.85
Sulphur, roll	ton	Nominal		
Tin bichloride, 50 deg.	lb.	.23½	—	.24½
Tin oxide	lb.	.85	—	1.00
Zinc carbonate	lb.	.22	—	.25
Zinc chloride	lb.	.10½	—	.11
Zinc cyanide	lb.	Nominal		
Zinc dust 350 mesh	lb.	.17	—	.18
Zinc oxide, American process XX	lb.	.11½	—	.12
Zinc sulphate	lb.	.06	—	.07

## Coal Tar Products (Crude)

Benzol, pure, water white	gal.	.35	—	.40
Benz 4, 90 per cent.	gal.	Nominal		
Toluol, pure water white	gal.	.35	—	.50
Xylo, pure, water white	gal.	.17	—	.22
Solvent naphtha, water white	gal.	.13	—	.16
Solvent naphtha, crude, heavy	gal.	.33	—	.35
Cresote oil, 25 per cent.	gal.	.29	—	.30
Dip oil, 20 per cent.	gal.	8.00	—	20.00
Pitch, various grades	ton	1.05	—	1.10
Carbolic acid, crude, 95-97 per cent.	lb.	.60	—	.65
Carbolic acid, crude, 50 per cent.	lb.	.35	—	.38
Carbolic acid, crude, 25 per cent.	lb.	.18	—	.20
Cresol, U. S. P.	lb.			

## Intermediates, Etc.

Alpha naphthol, crude	lb.	1.10	—	
Alpha naphthol, distilled	lb.	1.60	—	
Alpha naphthylamine	lb.	.68	—	.60
Aniline oil, drums extra	lb.	.26	—	.27
Aniline salts	lb.	.32	—	.34
Anthracene, 80 per cent.	lb.	.50	—	.65
Benzaldehyde	lb.	4.00	—	4.50
Benzidine, base	lb.	1.75	—	1.85
Benzidine, sulphate	lb.	1.40	—	1.50
Benzoic acid	lb.	4.00	—	4.85
Benzoyl chloride	lb.	7.00	—	8.00
Beta naphthol benzoate	lb.	.50	—	2.65
Beta naphthol, sublimed	lb.	.85	—	2.65
Beta naphthylamine com.	lb.	.12	—	.18
Dichlor benzol	lb.	4.00	—	5.00
Diethylaniline	lb.	.34	—	.42
Dinitro benzol	lb.	.40	—	.42
Dinitrochlorbenzol	lb.	.65	—	.60
Dinitronaphthalene	lb.	.55	—	.60
Dinitrotoluol	lb.	.65	—	.67
Dinitrophenol	lb.	.57	—	.52
Dimethylaniline	lb.	.85	—	1.00
Diphenylamine	lb.	2.25	—	2.50
H-acid	lb.	1.85	—	2.00
Metaphenylenediamine	lb.	.19	—	.22
Monochlorbenzol	lb.	.09½	—	.10
Naphthalene, flake	lb.	.10½	—	.10½
Naphthalene, balls	lb.	1.40	—	1.50
Naphthionic acid, crude	lb.	1.00	—	1.10
Naphthylamine-di-sulfonic acid	lb.	.45	—	.50
Nitro naphthalene	lb.	.50	—	.55
Nitro toluol	lb.	1.00	—	1.20
Ortho-amidophenol	lb.	.75	—	1.00
Ortho-toluidine	lb.	3.50	—	4.00
Ortho-nitro-toluol	lb.	4.00	—	4.25
Para-amidophenol, base	lb.	1.05	—	1.15
Para-amido-phenol, H. Ch.	lb.	1.50	—	1.60
Paranitraniline	lb.	3.00	—	3.50
Para-nitro-toluol	lb.	2.25	—	2.50
Paraphenylenediamine	lb.	6.30	—	6.40
Para-toluidine	lb.	.53½	—	.55
Phthalic acid anhydride	lb.	6.50	—	7.50
Phenol, U. S. P.	lb.	12.00	—	12.50
Resorcin, technical	lb.	1.10	—	1.20
Resorcin, pure	lb.	1.85	—	2.00
Salicylic acid	lb.	.32	—	.35
Sulphonic acid	lb.	2.50	—	
Toluol	lb.	.75	—	.85
Toluidine-mixture	lb.			

## Petroleum Oils

Crude (at the Wells)			
Pennsylvania	bbl.	3.75	—
Corning, Ohio	bbl.	2.80	—
Somerset, Ky.	bbl.	2.55	—
Wooster, Ohio	bbl.	2.38	—
Indiana	bbl.	1.98	—
Oklahoma and Kansas	bbl.	2.12	—
Caddo, La., light	bbl.	2.00	—
Corcoran, Tex., light	bbl.	2.00	—
California	bbl.	.98	— 1.32
Gulf Coast	bbl.	1.00	—
Fuel Oil			
New York	gal.	.11	—
Pittsburgh	gal.	.07½	— .10
Oklahoma-Kans.	bbl.	1.50	— 2.35
Texas	bbl.	1.50	— 1.75
Los Angeles	bbl.	1.52	—
San Francisco	bbl.	1.45	—
Gasoline (Wholesale)			
New York	gal.	.24	—
Boston	gal.	.25	—
Pittsburgh	gal.	.26	—
Chicago	gal.	.21	—
Oklahoma	gal.	.25	—
San Francisco	gal.	.20½	—

## Lubricants

Black, reduced, 29 gravity, 25-30 cold test	gal.	.18	— .19
Cylinder, light	gal.	.32	— .33
Cylinder, dark	gal.	.30	— .31
Paraffine, high viscosity	gal.	.35	— .36
Paraffine, .903 sp. gr.	gal.	.27	— .28
Paraffine, .865 sp. gr.	gal.	.19	— .20

## Flotation Oils

(Prices at New York unless otherwise stated)

Pine oil, crude, f.o.b. Florida	gal.	.44	—
Pine oil, steam distilled, sp. gr. 0.925-0.940	gal.	.50	—
Pine oil, destructively distilled	gal.	.43	— .53
Pine-tar oil, sp. gr. 1.025-1.035	gal.	.30	—
Pine-tar oil, double refined, sp. gr. 0.965-0.990	gal.	.35	—
Pine oil, light, sp. gr. 0.950, tank cars, f.o.b. works	gal.	.37	—
Pine oil, heavy, sp. gr. 1.025, tank cars, f.o.b. works	gal.	.26	—
Pine tar, thin, sp. gr. 1.080-1.080	gal.	.32	—
Turpentine, crude, sp. gr. 0.980-1.000	gal.	.40	—
Hardwood oil, f.o.b. Michigan, sp. gr. 0.960-0.990	gal.	.21	—
Hardwood oil, f.o.b. Michigan, sp. gr. 1.06-1.08	gal.	.19½	—
Wood creosote, ref. f.o.b. Florida	gal.	.31	—

## Vegetable and Other Oils

China wood oil	lb.	.20	— .21
Cottonseed oil, crude	gal.	1.31	—
Linseed oil, raw, cars	gal.	1.28	—
Peanut oil, crude	gal.	1.37	—
Rosin oil, first run	gal.	.35	—
Rosin oil, fourth run	gal.	.66	—
Soya bean oil, Manchuria	lb.	.17½	— .18
Turpentine, spirits	gal.	.50	— .51

## Miscellaneous Materials

Barytes, floated, white, foreign	ton	40.00	— 50.00
Barytes, floated, white, domestic	ton	30.00	— 36.00
Beeswax, white, pure	lb.	.56	— .64
Casoin	lb.	.22	— .30
Chalk, light, precipitated, English	lb.	8.00	— 12.00
Feldspar	ton	1.00	— 1.50
Fuller's earth, powdered	100 lb.	.65	— .75
Osokerite, crude, brown	lb.	.75	— 1.00
Osokerite, American, refined, white	lb.	.10	— .11½
Red lead, dry, carloads	lb.	7.20	—
Rosin, 280 lb.	bbl.	10.00	— 12.50
Soapstone	ton	15.00	— 22.00
Talc, American, white	ton	.09	— .10
White lead, dry	lb.		

## Refractories, Etc.

(F.O.B. Works)

	net ton	Nominal
Chrome brick	50.00	55.00
Chrome cement, Grecian	35.00	40.00
Clay brick 1st quality fireclay	30.00	35.00
Clay brick, second quality	40.00	55.00
Magnesite, raw	85.00	90.00
Magnesite, calcined	135.00	140.00
Magnesite, Grecian, dead burned	50.00	60.00
Magnesia brick, Grecian, 9x4½x2½		
Silica brick		

## Ferroalloys

Ferrocobaltitium, 15-18 per cent, carloads, f.o.b. Niagara Falls, N. Y.	ton	160.00	—
Ferrocobaltium, per lb. of Cr	lb.	.40	— .45
Ferromanganese, domestic	ton	250.00	—
Ferromanganese, English	ton	325.00	—
Ferromolybdenum, per lb. of Mo	lb.	5.00	—
Ferrosilicon, 75 per cent, f.o.b. N. Y.	ton	165.00	— 175.00
Ferrosilicon, 50 per cent, carloads, del., Pittsburgh	ton	100.00	— 175.00
Ferrosilicon, 50 per cent, contract	ton	2.35	— 2.45
Ferrotungsten, 75-85 per cent, f.o.b. Pittsburgh	lb.	7.00	—
Ferroumranium, f.o.b. works, per lb. of U	lb.	3.50	— 4.50
Ferrovandium, f.o.b. works	lb.		

## Ores and Semi-finished Products

Antimony ore, per unit	unit	1.60	— 1.75
Chrome ore, 48 per cent minimum, f.o.b. Cal., per unit	ton	.90	—
Manganese ore, 48 per cent and over, per unit	ton	1.20	—
Manganese ore, chemical	ton	80.00	— 100.00
Molybdenite, per lb. of MoS <sub>2</sub>	lb.	2.25	— 2.30
Tungsten, Scheelite, per unit of WO <sub>3</sub>	ton	26.00	—
Tungsten, Wolframite, per unit of WO <sub>3</sub>	ton	24.00	— 26.00
Uranium oxide, 96%	lb.	3.25	— 3.60
Vanadium Pentoxide, 99%	lb.	10.50	—
Pyrites, foreign	unit	.16	— .18
Pyrites, domestic	unit	.25	— .30

# INDUSTRIAL

Financial, Construction and Manufacturers' News

## New Companies

**THE ALLIANCE IRON & STEEL CORPORATION**, New York. Capital, \$75,000. To engage in the manufacture of iron and steel products. Incorporators: H. F. Holly, H. C. Gable and G. D. Zahm, 261 Broadway.

**O. H. ANDERSON & COMPANY**, New York. Capital, \$50,000. To operate a plant for the manufacture of paper and paper specialties. Incorporators: O. H. Anderson, C. C. and E. Mandel, 163 St. Nicholas Avenue.

**THE ANIMAL BY-PRODUCTS COMPANY**, Miami, Fla. Capital, \$30,000. To engage in the manufacture of fertilizer. Incorporators: W. A. Henderson and L. C. Haughey, Miami.

**THE GEORGE BANTA PAPER COMPANY**, Menasha, Wis. Capital, \$30,000. To operate a plant for the manufacture of finished paper. Incorporators: George Banta, Sr.; George Banta, Jr., and R. E. Thickens, Menasha.

**THE BEST FOUNDRY COMPANY**, Brooklyn, N. Y. Nominal capital, \$9,000. To operate a local foundry. Incorporators: J. Danziger, U. S. Adler and L. B. Louis, 35 Nassau Street, New York.

**BLACKMAN & FINK**, New York. Capital, \$25,000. To engage in the manufacture of chemicals and allied products. Incorporators: M. Fink and J. and E. Blackman, 66 East Ninety-ninth Street.

**THE CENTRAL IRON & METAL COMPANY**, Paterson, N. J. Capital, \$25,000. To engage in the production of iron, steel and other metal products. Incorporators: B. and A. and J. Jacobs, and H. Hurwitz, Paterson.

**THE CLEVELAND BRASS PRODUCTS COMPANY**, Cleveland Heights, Ohio. Capital, \$3,000,000. To manufacture and fabricate brass, zinc, copper, etc. Incorporators: C. R. Hamilton, Edward C. Decust, Cleveland Heights; Mark W. Cole and M. S. Pollock, Dover, Del.

**THE COMMERCIAL CYLINDER COMPANY**, Hackensack, N. J. Capital, \$500,000. To manufacture gas, oils, etc. Incorporators: Cornelius Cole, Hackensack; A. R. Oakley, Pearl River, N. Y.; and Paul E. Britsch, Brooklyn, N. Y.

**DECK BROTHERS**, Buffalo, N. Y. Capital, \$35,000. To operate a local foundry and machine shop. Incorporators: A. G. Bartholomew, B. L. Lempenau and A. S. Perera, Buffalo.

**THE DUNLAP PAPER COMPANY**, Batavia, N. Y. Capital, \$15,000. To engage in the manufacture of paper. Incorporators: M. Clark, S. Dunlap and A. Hawkins, Batavia.

**THE EAST DEERING FOUNDRY COMPANY**, Portland, Me. Capital, \$10,000. To engage in a general foundry business. Incorporators: George H. Thomas, Charles E. Noyes, Joseph G. Noyes and A. F. Thomas, all of Portland.

**THE EUREKA ANILINE PRODUCTS CORPORATION**, New York. Capital, \$10,000. To engage in the manufacture of dyestuffs and allied products. Incorporators: H. H. Suhr, H. P. Velte and R. Bennett, 503 West 169th St.

**THE FABRICATED STEEL PRODUCTS CORPORATION**, New York. Capital, \$150,000. To engage in the manufacture of steel products. Incorporators: W. E. I. Lambrecht, H. Lindemann and W. Arnold, 322 Tenth Avenue.

**THE GLIDDEN COMPANY**, Cleveland, Ohio. Capital, \$10,000. To manufacture paints, etc. Incorporators: Howard T. Clark, C. C. Owens, Ellis B. Diehm, Paul J. Bickel and Sterling Newell, Cleveland.

**GOLDSMITH BROTHERS SMELTING & REFINING COMPANY**, Atlanta, Ga. Capital, \$10,000. To engage in the smelting and refining of metals. Incorporators: Frank H. Leslie, Atlanta; Lowell A. Lawson and Leon L. Lewis, both of Chicago, Ill.

**THE GOOD CHANCE MINING COMPANY**, Miami, Okla. Capital, \$30,000. To mine for lead and zinc. Incorporators: George Ostrander, Miami; R. W. Eastman and H. H. Sherman, Alva, Okla.

**THE GREAT FINDS OIL & REFINING COMPANY**, Wilmington, Del. Capital, \$50,000. To drill for oil and gas and refine same.

**THE GREAT SCOTT MINING COMPANY**, Kansas City, Mo. Capital, \$25,000. To engage in the mining of lead and zinc. Incorporators: E. A. MacBride, A. B. Munsey and J. J. Johnston, Kansas City.

**THE HELLER & MERZ COMPANY**, Newark, N. J. Capital, \$1,500,000. To engage in the manufacture of chemicals, dyes, etc. Incorporators: A. Foshay, A. G. Thanum and Arthur Williams, all of New York.

**THE HOFFMAN-PERRY IRON & STEEL COMPANY**, Youngstown, Ohio. Capital, \$75,000. To deal in iron and steel products. Incorporators: Louis Hoffman, Frank C. Hoffman, Frank W. Perry, M. J. Sussman and G. F. Hammond, Youngstown.

**THE HOME PULP & PAPER MILLS COMPANY**, Mobile, Ala. Capital, \$100,000. To manufacture paper and paper products. Incorporators: F. B. Armstrong, J. S. Armstrong and M. McGowan, all of Mobile.

**THE LAMBERT CHEMICAL COMPANY**, St. Louis, Mo. Capital, \$30,000. To manufacture chemicals and allied products. Incorporators: W. and A. W. Lambert and A. R. Deacon, St. Louis.

**S. B. LEONARDI & COMPANY**, New York. Capital, \$10,000. To manufacture chemicals and kindred products. Incorporators: B. and A. B. and S. B. Leonardi, New Rochelle.

**THE MANVILLE MANUFACTURING CORPORATION**, New York. Capital, \$300,000. To manufacture chemical fire extinguishers. Incorporators: S. Bennett, Jr.; R. Sherman and R. W. Evans, 14 Wall Street.

**THE MERCHANTS FERTILIZER & PHOSPHATE COMPANY**, Charleston, S. C. Capital, \$25,000. To manufacture fertilizer and phosphate. Incorporators: E. H. Pringle, Jr.; B. G. Pringle, F. E. Barron and A. F. Pringle, Charleston.

**THE MERRIMAC VENEER COMPANY**, Byram, Miss. Capital, \$50,000. To manufacture paints, varnishes, etc. Incorporators: Frank and Robert Morrison and Thomas McCashe.

**THE METSKIN COMPANY**, Rochester, N. Y. Capital, \$10,000. To manufacture chemicals. Incorporators: A. E. Van Houten, C. H. and G. B. Miller, Rochester.

**THE NATIONAL REDUCTION COMPANY**, Dover, Del. Capital, \$1,100,000. To manufacture charcoal, tar and turpentine from wood, etc. Incorporators: Guy V. Ferguson, James H. Kirkpatrick, New York; Farke L. Woodward, Great Kills, Staten Island, N. Y.

**THE NITRO CHEMICAL CORPORATION**, Wilmington, Del. Capital, \$2,000,000. To manufacture explosives of all kinds.

**THE PEOPLES MUTUAL LEAD & ZINC COMPANY**, Muhall, Okla. Capital, \$1,000,000. To mine for lead and zinc. Incorporators: G. M. and W. C. Wolfe, and Thurman Ellison, Muhall.

**THE PURITAN STEEL COMPANY, INC.**, New York. Capital, \$50,000. To manufacture iron and steel. Incorporators: Herman Brasch, William J. Miller and T. T. Teichberg, New York.

**THE RICHVALE FURNACE COMPANY**, New York. Capital, \$1,000,000. To manufacture furnaces. Incorporators: Samuel B. Howard, G. V. Reilly and A. W. Britton, 65 Cedar Street.

**THE SEQUOYAH OIL REFINING COMPANY**, Dallas, Tex. Capital, \$50,000. To engage in the production of oil and the refining of same.

**THE STAR CHEMICAL MANUFACTURING COMPANY**, Los Angeles, Cal. Capital, \$10,000. To manufacture chemicals and allied products. Incorporators: Hyman Feder, K. M. Bonoff, D. A. Monheit and E. V. Rosenkranz, all of Los Angeles.

**THE STAYWITE COVERING COMPANY**, Queens, N. Y. Capital, \$10,000. To manufacture paints, enamels, lacquers and celluloid surface coating. Incorporators: H. Harjes, J. F. Hicks and H. J. Crofield, 560 Rogers Avenue, Brooklyn.

**THE STEPHEN ENGINEERING COMPANY**, Dover, Del. Capital, \$500,000. To manufacture furnaces and appliances.

**THE TRUMAN M. SMITH MACHINE COMPANY**, Grand Rapids, Mich. Capital, \$60,000. To engage in the manufacture of foundry products. Incorporators: T. M.

Smith, Jr.; I. P. Rice and Gerald McCoy, Grand Rapids.

**THE VOSS ALCOHOL EXPORT CORPORATION**, New York. Capital, \$50,000. To manufacture alcohol, etc. Incorporators: H. W. Voss, G. A. Moore, 27 William Street; R. E. Voss, 123 West Ninety-fifth Street, New York.

## Construction and Operation

### Alabama

**BIRMINGHAM**.—The Sloss-Sheffield Steel and Iron Company is planning for the early operation of its Hattie Ensley Furnace No. 2, under daily capacity of about 300 tons. Repairs made at the furnace have cost over \$300,000.

**BIRMINGHAM**.—The National Cast Iron Pipe Company, which recently filed notice of an increase in its capitalization from \$350,000 to \$500,000, is planning for the immediate erection of additions to its plant to increase the present capacity. Included in the work will be a new steel and cement foundry building, about 50 x 200 ft., which will be equipped with cranes, cupolas and facing and drilling machines for flange pipe.

**HOLLINS**.—The Parkdale Graphite Products Company, recently incorporated with a capital of \$100,000, has completed its organization arrangements and is planning for the immediate development of 200 acres of land. It is said the output of the plant will be approximately ten tons of graphite each hour. Headquarters of the company are at Talladega. R. G. Nickles is president and manager; A. H. Sawyer, Hollins, is construction engineer.

### Arkansas

**HARRISON**.—The Kreuger-Mills Mining Company, recently organized by W. O. Kreuger and E. H. Mills, of Springfield, Mo., has acquired 300 acres of land in connection with a large plant and is planning for immediate operations for the production of lead and zinc. The company will also make improvements in the works to cost about \$20,000.

### California

**BAKERSFIELD**.—The Standard Oil Company is planning for the construction of a new machine shop at its plant at McKittrick.

**BERKELEY**.—Feet Brothers, manufacturers of soaps, are planning for the construction of a large new factory at their local works. Head offices of the company are at Kansas City, Mo.

**MARTINEZ**.—The Atlas Powder Company has acquired a large tract of land, consisting of 206 acres, just north of its plant, and it is reported that the property will be used for extensive additions to its present works. The property was secured at a price of \$50,000.

**SAN DIEGO**.—The United States Shipbuilding Company has recently inaugurated active work for the construction of its proposed shipbuilding plant on property recently acquired on the tidelands, San Diego Bay. The company is said to be negotiating with the Emergency Fleet Corporation for the construction of ten steel vessels, with total capacity of about 90,000 tons, at the new plant. Adam Weckler is manager.

**WEST OAKLAND**.—The Southern Pacific Railroad Company is planning for extensive improvements and alterations in its crossting plant to cost about \$350,000. The plant will be completely modernized, and with extensions, will cover about 25 acres of land. The works will have a crossting capacity of about 3,000,000 ft. of lumber per year. J. A. Barlow is assistant chief engineer.

### Connecticut

**STAMFORD**.—The John Davenport Foundry Company is having plans prepared for the construction of a new two-story concrete factory building, about 90 x 300 ft., to be erected on Davenport Place. The estimated cost of the structure is \$90,000. Henry Marvin, Main Street, Stamford, is architect.

**WEST HAVEN**.—The Consolidated Rendering Company, 69 North Market Street, Boston, Mass., is making rapid progress in the construction of a new one-story local plant, about 15 x 220 ft. U. G. Carmichael, 902 Chapel Street, New Haven, is the contractor.



## Georgia

**ATLANTA.**—Plans have been completed for the erection of the proposed new plant of the Doss Rubber & Tube Company at Fort McPherson. The works will be about 55 x 142 ft., one-story, of stone and brick, and will have floor space of approximately 18,000 sq. ft. When completed the factory will have a capacity of 500 inner tubes and 500 casings daily. The Pittman Construction Company, Atlanta, is the contractor.

## Illinois

**BLUE ISLAND.**—The American Wire Fabrics Company, 208 South LaSalle Street, Chicago, is having plans prepared for the construction of a large new local plant to cost about \$200,000. Frank D. Chase, 122 South Michigan Avenue, Chicago, is the architect and engineer.

**CHICAGO.**—Rapid progress is being made by the Chicago Bearing Metal Company, 2234 West Forty-third Street, in the construction of a new one-story addition, about 102 x 226 ft., to its bearing metal plant, to cost \$15,000.

**CHICAGO.**—The Hughes Electric Heating Company, Waller Avenue and Taylor Street, has taken out a building permit for the construction of a new one-story plant, about 87 x 250 ft., to be used for the manufacture of electric heaters.

**EAST ALTON.**—Construction has been commenced by the Consolidated Chemical Products Company on a new one and two-story factory, about 75 x 235 ft., to cost \$50,000.

**EAST ST. LOUIS.**—The Durbin Automatic Train Connector Company, Pontiac Building, has awarded a contract to the F. Woerman Construction Company, Century Building, St. Louis, Mo., for the erection of a new foundry building on Bond Avenue, to cost \$25,000.

## Indiana

**FT. WAYNE.**—The Supreme Motor Corporation, Union Building, Cleveland, Ohio, is having revised plans prepared for the construction of a new one-story local plant, about 100 x 400 ft., to cost \$300,000.

**FT. WAYNE.**—Rapid progress is being made by the General Electric Company in the construction of a new factory building at its local works. Contract has been awarded to the Bedford Stone & Construction Company, Fletcher Trust Building, Indianapolis, Ind.

**HAMMOND.**—The Standard Steel Car Company, Frick Building, Pittsburgh, Pa., has completed plans for the erection of a new one-story addition to its local machine shop, about 250 x 800 ft., of brick and steel construction, to cost \$250,000. Contract has been awarded to the McClintic-Marshall Construction Company, Oliver Building, Pittsburgh.

## Kansas

**WICHITA.**—The Benjamin J. Sibbitt Iron Company has acquired property on Santa Fe and First Streets, about 132 x 290 ft., for a consideration of \$16,000, and is having plans prepared for the erection of a new one-story brick foundry, which will be operated in addition to its present structural works.

## Louisiana

**NEW ORLEANS.**—The New Orleans Refining Company has acquired a large tract of land on the old Sarpy plantation, near New Orleans, as a site for the construction of a new oil refinery.

**NEW ORLEANS.**—The Gasoline Corporation has recently acquired a site of land having a frontage of about 1000 ft. on the Mississippi River and about 50 acres deep, and is said to be planning for the construction of a large new plant for the refining of gasoline.

## Maryland

**CURTIS BAY.**—The Associated Chemical Company, manufacturer of fertilizer, etc., is planning for the construction of new additions and extensive improvements in its local plant. Headquarters of the company are at Hagerstown.

**BALTIMORE.**—The Bartlett-Hayward Company has awarded a contract to Morrow Brothers, Fidelity Building, Baltimore, for the construction of a new two-story brick, steel and concrete foundry at Scott and McHenry Streets.

**BALTIMORE.**—The Hess Steel Corporation is planning for extensive improvements and additions to its plant to provide for increased capacity, to include the erection

of a new mill-construction plant building, containing about 19,000 sq. ft. of floor space, and a new administration building. The new equipment will consist of electric melting furnaces, cranes, pouring equipment, etc., for the production of electric-furnace alloy steel.

## Michigan

**GRAND RAPIDS.**—The Tannewitz Works, 315-31 Front Street, have had plans prepared for the construction of a new two-story brick and steel addition, about 96 x 96 ft., to its factory and machine shop. Pierre Lindhout, National City Bank Building, Grand Rapids, is the architect.

**LANSING.**—The Lansing Chemical Company has awarded a contract for the erection of two one-story additions to its chemical manufacturing plant, about 50 x 50 and 50 x 100 ft., respectively, to William T. Britten, 821 West Ottawa Street, Lansing.

## Minnesota

**MINNEAPOLIS.**—A new one-story brick foundry addition to its plant, about 195 x 297 ft., will be erected by the Gas Traction Foundry Company, 1907 Fourth Street. The structure will cost about \$70,000. Plans are being prepared by W. L. Alban, Endicott Building, St. Paul.

## Missouri

**KANSAS CITY.**—Contract has been awarded by the Oxygen Gas Company, Traders Building, for the construction of its proposed new one-story and basement factory, about 44 x 120 ft., to cost \$60,000. A. G. Harper, Indiana Avenue, is the contractor.

**ST. LOUIS.**—The Wagner Electric Company, 6400 Plymouth Avenue, has awarded a contract for the construction of a new one-story plant, about 130 x 512 ft., to cost \$60,000. The new works will be devoted to the manufacture of ammunition. W. M. Sutherland Building & Contracting Company, Syndicate Trust Building, St. Louis, has the contract for erection.

**ST. LOUIS.**—The American Manufacturing Company, 1026 South Eleventh Street, is having plans prepared for the construction of a new one-story brick and concrete power plant, about 60 x 80 ft., at East St. Louis, Ill., to cost \$40,000. Kilpstein & Rathman, Chemical Building, St. Louis, are the architects.

## Nebraska

**OMAHA.**—The Sprague Tire & Rubber Company, Twentieth and Harney Streets, is having plans prepared for the erection of a new three-story and basement tire and rubber plant on Izard Street, between Eighteenth and Nineteenth Streets, to cost about \$200,000. George B. Prinz, 1033 Omaha National Bank Building, is architect.

## New Jersey

**CAMDEN.**—The New York Shipbuilding Corporation has awarded a contract to the J. S. Rogers Company, Moorestown, for the construction of a one-story addition to its plant, about 50 x 130 ft., to be used as a galvanizing plant. The structure will cost \$10,000.

**RIDGEFIELD PARK.**—The British-American Chemical Company, 52 Vanderbilt Avenue, New York, has acquired the plant and property of the Tennessee Copper Company, Ridgefield Park, and is planning for the construction of several new additions, the entire works to be devoted to the manufacture of chemicals.

**JERSEY CITY.**—Fire, on Dec. 21, destroyed a portion of the plant of the George H. Segal Company, Inc., 139-141 Logan Avenue, manufacturer of chemicals, with loss estimated at approximately \$40,000.

**NEWARK.**—Fire, on Dec. 22, destroyed the plant of the Newark Rubber Company, 192 Emmet Street, with loss estimated at \$50,000, of which \$30,000 is for machinery.

**PERTH AMBOY.**—The Roessler & Hasselacher Chemical Company is planning for the immediate construction of a new one-story addition to its plant, about 60 x 165 ft.

**DUNELLEN.**—The Crescent Color & Chemical Works, 1735 West Front Street, is having plans prepared for the construction of a new two-story addition to its plant, about 70 x 80 ft., to cost \$10,000.

**SOUTH RIVER.**—The Para Products Company, manufacturer of rubber goods, is planning for the rebuilding of its plant recently destroyed by fire. The new works will be about 100 x 200 ft.

**NEWARK.**—Colgate & Co., manufactur-

ers of soaps and perfumes, have announced the acquisition of a tract of twenty acres at Port Newark Terminal on which a large plant will be built and where many new hands will be employed. No definite steps will be taken as to the building of this plant until the end of the war. This property is not far from the Submarine Boat Corporation's shipyards, and is along the same shore line of the American Synthetic Dye Works, and other large industries. It is in the neighborhood of the new locations on the Passaic and Hackensack rivers recently acquired by the Ford Motor Company, the United States Steel Corporation, and the Niles-Bement Pond Company.

## New York

**COLLEGE POINT, L. I.**—The American Hard Rubber Company, 11 Mercer Street, New York, has had plans prepared for extensive improvements and alterations in its local plant. Alexander Macintosh, 55 Bible House, New York, is the architect.

**BROOKLYN.**—The E. W. Bliss Company, Adams & Plymouth Streets, manufacturer of munitions, will build a new seven-story plant, about 200 x 350 ft., on property recently acquired on Fifty-third Street, near First Avenue, South Brooklyn. When completed the new plant will represent an investment of approximately \$1,400,000.

**BROOKLYN.**—Preliminary plans are being prepared by Louis Leavitt, 454 Driggs Avenue, for the construction of a new three-story and basement varnish factory, about 100 x 125 ft., at Driggs Avenue and North Eleventh Street, to cost about \$70,000. William A. Giesen, 104 West Forty-second Street, New York, is the architect.

**BROOKLYN.**—The National Lead Company, 111 Broadway, New York, has had plans prepared for the construction of a new three-story reinforced-concrete plant on Gold Street, from Marshall Street to Hudson Avenue. William Higginson, 21 Park Row, New York, is the architect.

**ALBANY.**—Fire recently destroyed a portion of the iron foundry of George H. Thatcher, Pleasant Street, which was engaged upon Government work. It is said that the destroyed section will be immediately rebuilt.

**TROY.**—The Rensselaer Polytechnic Institute, Broadway, will build a new four and five-story addition to its chemical laboratory, about 43 x 112 ft., and plans for the structure, which is estimated to cost \$120,000, are being prepared by Lawlor & Hasse, 69 Wall Street, New York.

**BUFFALO.**—Plans have been prepared by the American Car & Foundry Company, 350 Babcock Street, for the construction of a new paint shop at its works to cost about \$12,500.

**BUFFALO.**—The Pratt & Lambert Company, Tonawanda Street, manufacturer of paints, varnishes, etc., has taken out a building permit for the construction of a large addition to its plant to cost \$30,000.

## North Carolina

**MT. AIRY.**—The Tar Heel Manganese Company, recently incorporated with a capital of \$100,000, is planning for the immediate development of 80 acres of land for initial operations and increasing the capacity during the coming spring. W. P. Sinclair, Welch, W. Va., is treasurer.

**MURPHY.**—The Appalachian Iron & Mining Company, with plants at Blue Ridge and Ellijay, Ga., is planning for the installation of new machinery at its works, including portable compressors, tripod machine drills, gasoline locomotives, etc., for the mining of iron ore. S. Long of Etowah, Tenn., is president.

## Ohio

**AKRON.**—The Kelly-Springfield Tire Company, Kelly Avenue, has awarded a contract for the construction of a new two-story addition to its plant, about 48 x 87 ft., to cost \$10,000. W. A. Franklin Sons Company, 327 Cuyahoga Falls Avenue, has the contract for erection.

**AKRON.**—The B. F. Goodrich Rubber Company, manufacturer of rubber tires, etc., will build a new one-story mill room addition to its plant, about 112 x 150 ft., to cost \$20,000. Contract for erection has been awarded.

**CINCINNATI.**—The D. T. Williams Valve Company, Spring Grove Avenue and Township Street, has taken over the plant and property of the Queen City Brass & Iron Company, Spring Grove Avenue and Garrard Street, Camp Washington, for a consideration of \$300,000. The Williams company is planning for the immediate operation of the plant in addition to its present works, to provide for the steadily increasing demands for its product.

**BARBERTON.**—The Portage Rubber Company, Barberton, is making rapid progress in the erection of its new local plant. The works are estimated to cost \$75,000.

**CLEVELAND.**—The National Carbon Company has acquired property comprising about five city lots adjoining its carbon extraction plant at Scranton, Pa., and is planning for the construction of a large addition to provide for increased capacity.

**COKE OTTO.**—Plans are being prepared for extensive improvements and additions to the plant of the Hamilton Furnace Company, near Hamilton, to include the erection of a car dumper to cost about \$175,000; a new water softening plant, \$30,000, and a new ore bridge to cost \$150,000. The new improvements, when completed, will represent an expenditure of about \$500,000.

**DAYTON.**—Contract has been awarded by the Wright Aeroplane Company to Frank Hill Smith, Inc., 120 Broadway, New York, for the construction of a new one-story addition to its plant, about 300 x 1000 ft., to cost \$100,000.

**MANSFIELD.**—A new one-story factory building will be constructed by the Phoenix Electric Company, Olivesburg Road, to provide for increased capacity. The structure, which will be about 50 x 100 ft., will cost \$10,000. Contract has been awarded to Simon Small & Son, Bird Building, Mansfield.

**MARIETTA.**—Plans have been prepared by the Leidecker Tool Company, 119 Second Street, for the erection of a new one-story plant, about 100 x 175 ft., concrete and steel construction, at Westview, near Marietta. Foster Leidecker is general manager.

**MCDONALD.**—The Carnegie Steel Company has awarded a contract to the Youngstown Foundry & Machine Company, Youngstown, for the installation of a new 10-in. hoop mill at its local works.

**URBANA.**—The Central Glass Company, which has taken over the plant of the Eagle Glass Company, has completed improvements and alterations at the works, costing about \$100,000, and is planning to inaugurate operations at an early date.

### Oklahoma

**MIAMI.**—The Miami Zinc & Lead Syndicate, recently incorporated with a capital of \$5,000,000, has acquired the property of the St. Louis Mining & Smelting Company, including 1400 acres of mineral lands, and is said to be planning for the construction of several large mills and a smelter plant.

### Pennsylvania

**BURNHAM.**—The puddling furnaces of the Logan Iron & Steel Company were closed temporarily on Dec. 20, due to coal shortage.

**CATASAUQUA.**—The Crane Iron Works has banked one of its stacks for lack of coke. As soon as conditions improve the plant will be reopened.

**ERIE.**—The American Sterilizer Company, Twelfth and Plum Streets, is making rapid progress in the construction of the new one-story brick addition to its plant, 50 x 70 ft., to cost \$10,000. The Stader Conrath Construction Company, Palace Hardware Building, Erie, is the contractor.

**PUNXSUTAWNEY.**—Fire recently destroyed the plant of the Eldred Window Glass Company with loss estimated at \$200,000. The company is planning for the immediate reconstruction of the plant.

**READING.**—The Reading Iron Company has completed improvements, including the relining of its Keystone blast furnace, and is planning to place the stack in operation at an early date.

**MOOSIC.**—Fire on Dec. 19, caused by an explosion, destroyed a portion of the plant of the duPont Powder Company, with loss estimated at \$25,000.

**WILLIAMSPORT.**—The Valley Iron Works, 209 West Street, has awarded a contract for the construction of a new two-story plant, about 45 x 75 ft., to cost \$15,000. J. V. Bennett & Company, 309 West Third Street, Williamsport, is the contractor.

### Tennessee

**HARRIMAN.**—Joseph and William Baker have acquired the plant and property of the Harriman Mine Car Manufacturing Company, and are planning for the construction of several new additions and extensive improvements to increase the present capacity.

**NASHVILLE.**—Reports from Nashville, Tenn., are to the effect that E. I. duPont

de Nemours & Co. is planning to erect a big plant in Big Bend, near Nashville, it being stated that the plant will employ about 4000 persons. Whether this plant will manufacture dyestuffs or explosives has not been definitely stated. According to the Nashville Banner, Daniel Caulfield, real estate purchasing agent for the duPonts, has definitely stated that the company would employ 4000 people at a plant to be located in Big Bend.

### Texas

**RUSK.**—The Texas Steel Company, Beaumont, has acquired the Rusk foundry property for a consideration of \$112,500, including iron furnace, pipe foundry, etc., and is planning for extensive improvements and the reopening of the blast furnace, to have a capacity of 120 tons of iron daily.

**BROWNSVILLE.**—The LaBlanca Sugar Company, recently organized with a capital of \$500,000, has acquired the sugar factory of the LaDonna Sugar Company, near Donna, with 4000 acres of land adjoining the plant in Hidalgo County; also 8000 acres of land in Cameron County, and is planning for extensive improvements in the plant acquired to cost about \$50,000. J. G. McDowell, Pittsburgh, Pa., is president.

### Virginia

**ST. PAUL.**—The Clinch Valley Chemical Company, recently incorporated with a capital of \$5,000,000, has had plans prepared for the construction of a large by-product plant. It is anticipated that the plant will be in operation early in the spring.

### West Virginia

**CHARLESTON.**—The Powhatan Brass & Iron Works has awarded a contract to Glazie & Brother, Winchester, Va., for the construction of a new one-story foundry at its plant.

### Wisconsin

**MADISON.**—The Four Lakes Ordnance Company, 2305 Waunesa Street, is making rapid progress in the construction of its new one-story plant, about 150 x 590 ft., which will be devoted to the manufacture of guns. It is estimated that the plant, when completed, will cost \$1,000,000. The Austin Company, Euclid Avenue, Cleveland, Ohio, is the contractor.

**MILWAUKEE.**—The Milwaukee Paper Box Company, manufacturer of paper boxes and kindred products, is having preliminary plans prepared for the construction of a new plant to cost about \$150,000, to provide for increased capacity.

**MILWAUKEE.**—The Liberty Foundry Company, 967 Grand Boulevard, has commenced the erection of a new one-story foundry, about 65 x 120 ft., on Watertown Plant Road, to cost \$15,000. J. D. Morrison, 625 Sixty-ninth Avenue, West Allis, is the contractor.

**MILWAUKEE.**—The Gerlinger Steel Casting Company, specializing in the production of steel castings, has commenced the construction of two new additions to its plant, each 40 x 50 ft., to provide for increased capacity. John J. Gauser, West Allis, is the contractor.

## Manufacturers' Catalogs

**THE WILSON WELDER & METALS COMPANY, INC.,** New York City, has issued catalog No. 2, describing the Wilson system and giving considerable general information of value in welding.

**THE AMERICAN HARD RUBBER COMPANY,** 11 Mercer Street, New York City, has issued a very attractive catalog describing its line of acid pumps, piping and utensils.

## Other New Publications

**CALIFORNIA MINERAL PRODUCTION FOR 1916,** with county maps. Bulletin No. 74 of the California State Mining Bureau. Ferry Building, San Francisco. Walter W. Bradley, author.

**MATERIALS FOR THE HOUSEHOLD.**—Circular No. 76 of the Bureau of Standards. Issued Dec. 5, 1917. Price 25 cents. From Superintendent of Documents, Government Printing Office, Washington, D. C. Contains valuable information for manufacturers of products used in the household.

## Trade Notes

**N. B. PAYNE** has opened an office in the Havemeyer Building, 25 Church Street, New York, as an electric crane specialist, supplying new and used traveling cranes. Mr. Payne was formerly associated with Manning, Maxwell & Moore, Inc., New York.

**THE ECONOMY ENGINEERING COMPANY** of Chicago, manufacturer of tiering machinery and portable elevators, has established its own New York office at 85 Murray Street. The company was formerly represented in New York by the Standard Scale & Supply Company.

**GRASSELLI CHEMICAL COMPANY TO INCREASE CAPITAL.**—There will be a special meeting of the stockholders of the Grasselli Chemical Company on January 24, at which the stockholders will vote on a proposition to increase the company's authorized capital from \$20,000,000 to \$50,000,000. The plan is understood to include an increase of the authorized issue of preferred shares from \$5,000,000 to \$15,000,000, and the common stock from its present issue of \$15,000,000 to \$35,000,000.

**STANDARDIZATION OF DYE STUFFS.**—Upward of 200 company representatives and individuals from all parts of the country have expressed their intention of attending the two-day meeting which is to be held in Rumford Hall of the Chemists' Club, No. 50 East Forty-first Street, on January 22 and 23 to further the movement which has been initiated to standardize American dyestuffs and aniline colors. Practically all of the leading manufacturers and dealers have approved the movement and promised to attend. H. Gardner McKerrow, manager of the textile department of E. F. Drew & Co., who has handled all of the details of the proposed meeting, will open the convention as temporary chairman.

In addition to standardization of dyestuffs and colors, the meeting will give consideration to several other matters of prime importance to the dye and dyestuffs industry. Among the latter may be mentioned the question of tariffs, arbitration of disputes, and protection of contracts. Numerous other matters which properly come within the function of a trade association will be discussed, as it is stated that the initial idea is to form a "National Dyestuffs Association," which will fill the same relation to the industry as do various cotton and woolen and other trade associations to their industries.

**NEW SWEDISH DYE COMPANY.**—The A. B. Kemisk Industrie, a new company, has taken over the undertaking carried on for a year and a half under the same title by A. V. Holson, for the production of coal-tar dyes. The new company proposes to extend the works so as to be able also to produce chemical materials of importance to Swedish industries, particularly for the manufacture of munitions. It is believed that it will be possible to begin the manufacture next autumn of about 100 different dyes. The company will have the largest laboratory in Sweden and will employ a staff of from 25 to 30 chemists, whose numbers will be gradually increased. The share capital has been fixed at 5,000,000 kr. (\$1,330,000). It is stated that the works have already produced a number of dyes which in every respect appear to compare well with German products. The Swedish requirements amount to 10,000 tons per annum, and to those attention will first be paid. As raw materials to be used are principally mentioned benzol from the Swedish gasworks, acids, bases, salts, etc., which for the most part are produced in the country, which also is able to provide most of the machinery and plant required. The Superfosfat Fabriks A. B., of Stockholm, which is the principal Swedish chemical industry company, has an interest in the undertaking.

**OTHER NEW SWEDISH INDUSTRIES.**—Scarcity of fats of every description has caused the creation of new industries in all European nations for the production of fats of every kind from sources hitherto considered unpromising. In Malmö, Sweden, a new corporation has been organized named the Aktiebolaget Fedtindustri, with a capital of \$1,340,000, to produce fats from bones and any other material that yields fat good for soap and other industrial purposes.

A corporation named the Högånäs-Billesholm Aktiebolaget is investigating an invention for producing aluminum out of the clay found in the vicinity of Högånäs, Sweden. A new factory will probably be built near Trollhättan, which will be able to utilize economically about 6000 hp. from the large waterfalls at that place.

One of the industries developed by the war is the Svenska Elektron, which was organized at the end of 1915 with a capital of \$53,600. The capital is now being increased to \$265,000 to carry on the additional business that is constantly developing in the silver and other metal specialties made by the company.